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PB-297 035

Areawide Waste Treatment and Water Quality Management Planning. Appendix C-1. Energy Report: Evaluation of Areawide Coal Production and Future Projections

Greater Egypt Regional Planning and Development Commission, Carbondale, IL

Prepared for

Environmental Protection Agency, Chicago, IL. Region V

Nov 78

Areawide Waste Treatment and Water Quality Management Planning

PB 297035

Energy Report: Evaluation of Areawide Coal Production and Future Projections

Appendix C-1

Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson Counties, Illinois

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Areawide Waste Treatment and Water Quality Management Planning

5

Energy Report: Evaluation of Areawide Coal Production and Future Projections

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The preparation of this report was financed entirely with federal funds from the U.S. Environmental Protection Agency under grant number P005225-01 through a contract with the Greater Egypt Regional Planning and Development Commission. The contents do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use. Publication No. GERPDC-78-493.

BIBLIOGRAPHIC DATA SHEET	1. Report No. GERPDC-78-493	2.	3. Recipient's Accession No.
4. Title and Subtitle Areawide Waste Treatment and Water Quality Management Planning Energy Report: Evaluation of Areawide Coal Production and Future Projections, Appendix C-1			5. Report Date November 1978 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Greater Egypt Regional Planning and Development Commission P.O. Box 3160 Carbondale, IL 62901			10. Project/Task/Work Unit No. 11. Contract/Grant No. P005225-01
12. Sponsoring Organization Name and Address U. S. Environmental Protection Agency Region V 230 South Dearborn Chicago, IL 60604			13. Type of Report & Period Covered Final 14.

15. Supplementary Notes

16. Abstracts

The Energy Report: Evaluation of Areawide Coal Production and Future Projections is Appendix C-1 of the Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The report was prepared under Section 208 of the Water Pollution Control Act, as amended. The report forecasts the extent of expansion of coal mining and related industries to be expected in the Southern Illinois 208 area between 1975 and 1980, 1981 to 1985, and 1986 to 1995. Particular emphasis is placed on identification of land uses that may change as a result of surface mining. Other matters of interest are the potential impact of coal gasification and liquification, as well as coal-fired power plants upon water quality, and the magnitude of population change to be expected as a result of all such developments.

17. Key Words and Document Analysis. 17a. Descriptors

Coal gasification, coal mines, coal development, coal exploitation, coal reserves, coal mining, electric power generation, electric utilities, electric power plants, water quality, water pollution.

17b. Identifiers/Open-Ended Terms

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
National Technical Information Service U.S. Department of Commerce Springfield, VA 22151	UNCLASSIFIED	112
	20. Security Class (This Page) UNCLASSIFIED	22. Price A06-A01

FORM NTIS-35 (REV. 3-72) THIS FORM MAY BE REPRODUCED USCOMM-DC 14952-P72

GREATER EGYPT REGIONAL PLANNING & DEVELOPMENT COMMISSION

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November 1978

Michael P. Mauzy
Acting Director
Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, Illinois 62706

Dear Mr. Mauzy:

The Commission is pleased to transmit Appendix C-1, Energy Report: Evaluation of Areawide Coal Production and Future Projections of the 208 Areawide Waste Treatment and Water Quality Management Plan for Southern Illinois. The plan and this document cover the ten Illinois Counties of Franklin, Gallatin, Hamilton, Hardin, Jackson, Jefferson, Perry, Pope, Saline, and Williamson.

This technical report is an integral part of the Southern Illinois Water Quality Management Plan that is designated to meet the contract requirements of Federal Grant Number P005225-01 under the U. S. Water Pollution Control Act Amendments of 1972, as administered by the United States Environmental Protection Agency.

We trust this submittal of this report, as well as the others comprising the plan, will provide the basis for certification of the plan and continued designation of this area.

Sincerely,

A. S. Kirkikis

A. S. Kirkikis
Executive Director

ASK:db

ACKNOWLEDGMENTS

The Greater Egypt Regional Planning and Development Commission and the Southeastern Illinois Regional Planning and Development Commission wishes to acknowledge the

United States Environmental Protection Agency

for financial assistance in the preparation of this report.

The Regional Commissions express their appreciation to the Illinois Environmental Protection Agency for their assistance and cooperation during the initial planning program.

In addition, the Regional Commissions would like to thank the members of the Technical and Policy Advisory Committees to the program; the Federal and State Agencies; and the many public officials and citizens too numerous to mention who have offered information and suggestions during the initial phase of the planning program.

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SUMMARY

This report forecasts the potential impact of coal industry and utility growth, especially as it relates to water quality concerns, for the period 1975-95 in the ten Illinois Counties of Franklin, Gallatin, Jackson, Jefferson, Hamilton, Hardin, Perry, Pope, Saline, and Williamson. Matters of concern include the Southern Illinois 208 area's coal resources, exploitation trends, future markets for area coal, expected levels of production by coal type and mine type, and consequent expected changes due to mines, coal conversion plants, and coal fired power plants. Special attention is given to assessing possible sites for such activities. A map of projected large scale surface mining for 1975-1995 was prepared, and the land uses shown to be affected were tabulated by acreages (this map is an output of the 208 project and is available for inspection at the Greater Egypt Regional Planning and Development Commission offices).

The 208 area's vast coal resources of over 25 billion tons are not all of economic interest to the mining industry in the forecast period. For large scale mining, some 7.9 billion tons of underground reserves and approximately 1.6 billion tons of surface reserves are available to support future mine capacity. In the last twenty years, the Southern Illinois 208 area has supported about 50% of Illinois' coal production on 17% of its resource base, reflecting intensive exploitation of low sulfur reserves (rare in the midwestern coal fields) for coking, industrial, utility, and domestic consumption. The remaining economically important low sulfur reserves are not as concentrated within the 208 region as in the past, and will prove less important since new sulfur reduction technology and new coke production technology will act to reduce dependence on these reserves. High sulfur coal sales to utilities are expected to increase significantly. This increase will depend to some extent upon action by the Illinois Public Service Commission to prohibit Illinois utilities from opening captive western low sulfur coal mines. Such action has been taken in West Virginia, Ohio, and Pennsylvania.

In the last 20 years the area's underground mines have increased in average size and declined in number, while production first increased and then returned to 1956 levels. Increased future underground production must be predicated on stabilized labor productivity, the introduction of longwall mining in Southern Illinois, and continued domination of the area's production by mines at or near record size. The

imposition of flue gas desulfurization systems on new utility plants makes previously unmined thick deposits of shallow, high-sulfur coal economically attractive. The southwestern shelf of the Illinois Basin, including Perry County, contains vast reserves of this kind. Production from such reserves is expected to expand rapidly to meet utility demand in southern and southeastern states between 1978 and 1985. A further cycle of growth will be based on these reserves if the proposed Illinois Coal Gasification Group coal conversion plant is built before 1995. Production from such traditional mining areas as Franklin, Williamson, and Jefferson County will grow only moderately and for short time periods. Jackson and Gallatin Counties should see stable to declining mine employment, as will Pope and Hardin Counties. Saline and Hamilton Counties will both increase in production and mine employment. Total coal production for the area was 34.9 million tons in 1972, and will be about 27 million tons in 1977. In 1985, production is forecast to reach 44.4 million tons, and 61.6 million tons in 1995. Surface production will form an increasing share of this total until the early 1980's but the percentage of total production from surface mines should decline thereafter, and total surface production should be in decline by 1995. In all, as much as 108,000 acres may be affected by large mines before 1995.

Ancther problem area for future water quality management will stem from small scale surface ("spot") mines exploiting unmapped minor seams both north and south of the most important band of surface mineable coal which crosses the 208 area.

The mining of coal reserves in Hardin and Pope Counties poses a potential threat to that area's high quality streams. Current mapping of these seams by the Illinois Geological Survey might be usefully accelerated, and additional attention should be paid to analysis of the acid-production-potential of strata overlying coal of surface mineable thickness and depth. While coal mining by "spot" mines is a very small fraction of total production, it has relatively high potential for pollutional discharge and/or reclamation failure. Recent regulatory changes under P.L. 95-87 (Surface Mining Control and Reclamation Act of 1977) will cause a substantial reduction in production by 1980, but this type of production is likely to increase rapidly after 1985.

When the increases in mining and related jobs are forecast, it is clear that only one type of activity has the potential to bring about community expansion at a rate in excess of area governments' capacities to maintain water quality services. Sites for large, commercial scale coal conversion plants exist in the northwestern and southeastern ends of the region, close to extensive coal and water supplies. The development of

at least one such plant by 1995 seems likely. Such a plant is actively being planned in western Perry County. The development of such a plant seems likely to introduce several thousand new residents to the northwestern half of Perry County in a short time period. Impacts in this area are expected to be mitigated by commuting among the construction labor force, as occurred during the recent completion of a smaller project, a 635 MW power plant at Baldwin. Further reduction of impact will stem from the absorption of secondary support jobs by local inhabitants, by the relative development of the area, and its accessibility to the St. Louis metropolitan area. Despite such reduction of potential population increases in western Perry and eastern Randolph Counties, they may face substantial problems in financing water and sewer service extensions to meet demand.

It is likely that similar large scale development may occur in Gallatin County shortly after 1995. The economic problems associated with rapid growth may be expected, but the mitigating factors which apply to Perry County will not necessarily operate to the same degree in the southeastern portion of the state.

The overall forecast for the 1975-1995 period can be summarized as follows:

Table 1
SUMMARY OF ENERGY-RELATED PROJECTIONS

	1971	1976	1980	1985	1990	1995
Total Coal Production (millions of tons)	31.3	29.5	34.8	44.4	52.4	61.6
Surface Mine Production (millions of tons)	12.8	16.2	18.6	21.5	25.3	26.1
Surface Mine Affected (agricultural acreage per year)	n/a	n/a	2823	5448	4876	3733
Total Surface Mine Affected (acreage per year)	2290	2634	4054	7168	6518	5217
Total Employment in Energy Facility Operations	5850	7651	8165	7692	9740	12454

Table 1 (Continued)

	1971	1976	1980	1985	1990	1995
Total Construction Employment on Energy Facilities	n/a	1039	765	1708	4807	0*

* This projection does not consider construction of facilities which begin operations after 1995, therefore, construction employment declines to 0 in 1995.

Source: GERP&DC staff, materials referenced in text.

In conclusion, mining will expand rapidly from 1980 to 1985, and again after 1990. Restricted available reserves for new surface mine capacity will limit large surface mine expansion, whose annual production will begin to decline before 1995. The affected acreage per year will increase rapidly until about 1990 and then decline. Employment will not increase rapidly except after 1985 and except in Perry County, where construction of a coal conversion facility is likely to place strain on existing water and sewer services.

Chapter 1

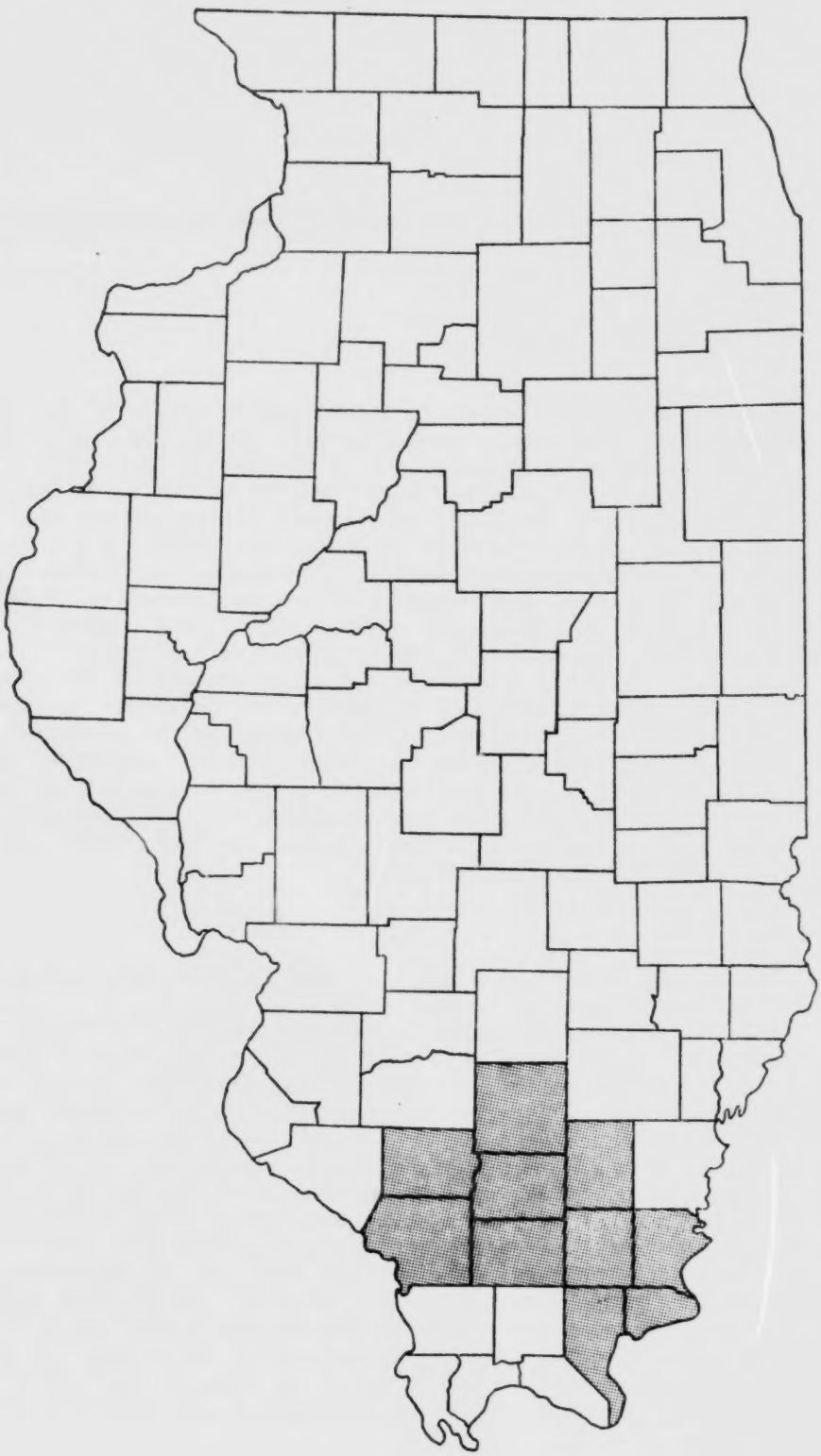
THE RESOURCE AND ITS RECENT HISTORY OF EXPLOITATION

Introduction

The purpose of this report is to provide forecasts of the potential impact of the 208 area's (see Figure 1) energy and energy-related industries on water quality managment in the period 1975-1995. Inasmuch as a separate staff document has been prepared to deal with the petroleum and gas industries in the area, this report focuses on the coal extraction industry and closely related secondary activities, e.g., coal-fired electric power generation and coal conversion facilities. Specifically, the end product of this report will be identification of those lands and their current uses which may undergo significant change due to the above activities. The potential impact of mining and energy programs on land use, it is assumed, will be felt through changes in the annual rate of land use by surface mining, by changes in the demand for water and waste treatment facilities stemming from changes in the quantity and location of employment opportunities resulting from the opening of new underground coal mines, and by the construction of electricity generation and coal conversion facilities near active mines. A major product of this research is a coal-related land use map for 1980, 1985, and 1995, which is available at GERP&DC offices.

Any forecast of future activities must be based upon assumptions about trends in influential factors. The coal industry is a competitive one, in which information concerning the future plans of mining concerns is considered proprietary, and planning and preparation is carried on with the minimum of public information. The forecasts in this report are therefore dependent on the extrapolation of past trends, and the limited information concerning the area's coal resources which is in the public domain. At the date of this writing, uncertainty in the growth of coal demand, delays in the delivery of equipment for new mines, and declines in labor productivity combine to make forecasting future trends unusually hazardous. It appears accurate to assume that federal regulations will be strict regarding prime farm land, and may restrict surface mining of coal in those portions of the 208 area. It has been considerably easier to forecast where mining and related activities will occur than when they will commence. Efficient use of this report as a water quality management tool in future years may require revision of forecasts presented here in the light of information not currently available.

Figure 1
The Southern Illinois 208 Region



The report is divided into four sections. The first provides baseline information, briefly outlining the location and quantity of the area's coal reserves, and discussing qualitative aspects of these reserves which are important in understanding the value of this resource relative to those of other coal-producing areas. The first section of the report concludes by reviewing trends in the area's coal industry in the period 1956-1975 which have implications relevant to future trends.

The second section of this report begins with a brief discussion of factors affecting future demand for the area's coal. This section reviews demand and production forecasts made for the State of Illinois, and for the Illinois Basin, and discusses their implications for the area. The importance of sulfur content and the future markets for 208 area coal are examined, and a forecast of demand for 208 area coal is presented.

Chapter Three of this report deals with constraints upon the production of coal imposed by the availability of cheaply exploitable reserves, labor productivity trends, and retirement of new and existing mining capacity. Chapter Two's forecasts of future production are reviewed to assess their implications in terms of the annual level of new mine capacity required to attain the projected output levels, and the division of that capacity between surface and underground sections of the industry. Chapter Three also attempts to locate future underground and surface mines.*

In the fourth chapter, several indirect impacts of coal-related growth are reviewed, including: the potential for water-related impact on community social services due to rapid and localized community growth from development of a synthetic fuels industry, intensified underground mining, and electricity generation development are discussed. In essence, this chapter nominates localities most likely to be affected. The degree of population change due to major projects is also discussed.

*The use of the terms reserves, demonstrated reserves, and resources in this report is explained in the Addendum to the notes for Chapter 1 on page 22.

The Nature of the Resource

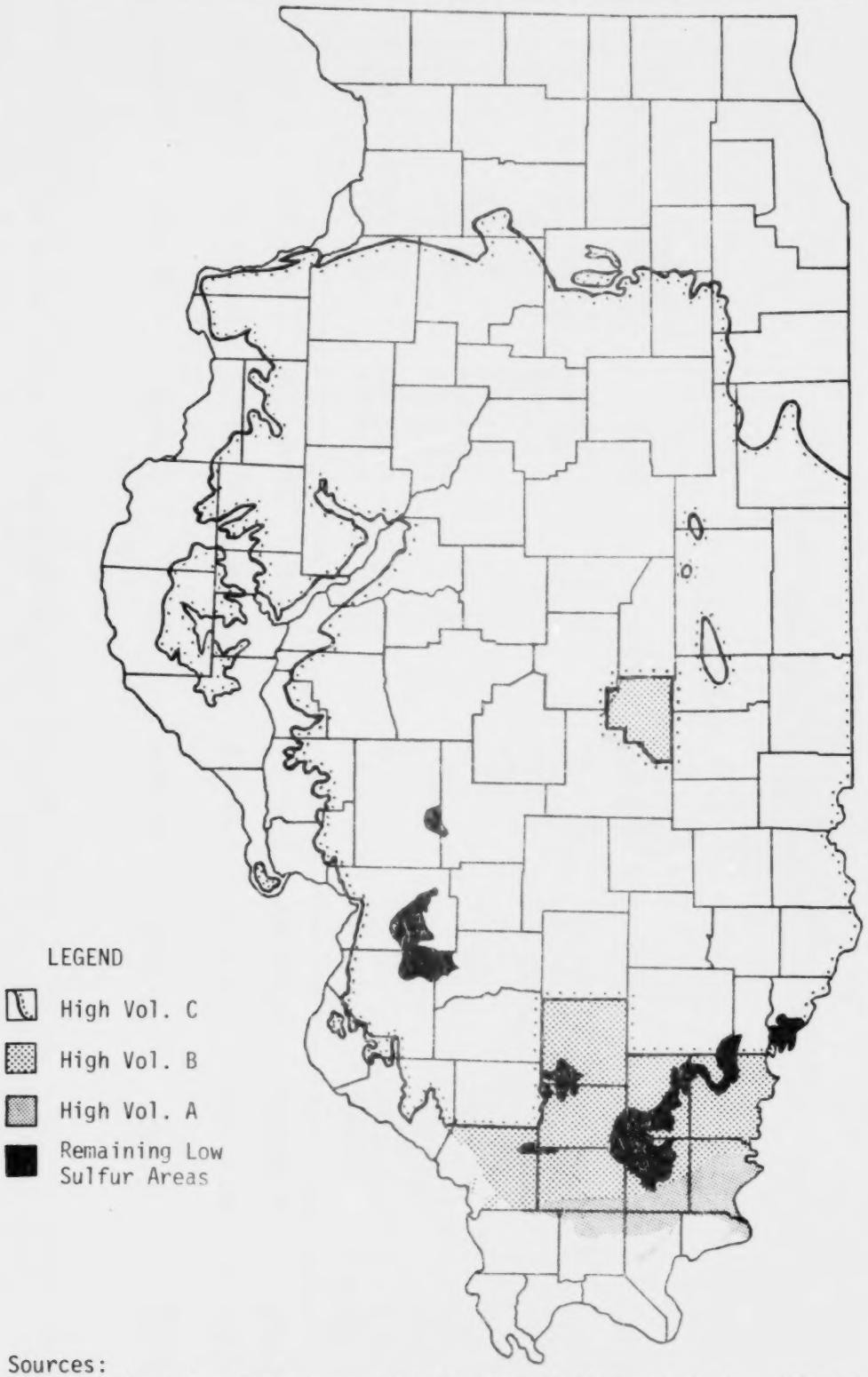
The 208 area is located above the southwestern tip of a geological structure called the Illinois Basin. This basin comprises many layers of sedimentary strata, and can be visualized as a giant plywood spoon underlying parts of Indiana and western Kentucky, as well as most of Illinois. Around the edge of this basin, the spoon's rim is close to the surface, and the layers of the spoon containing coal may be surface mined. Toward the center of the spoon, these layers may be 1000 feet or more beneath the surface, and require underground extraction. This "spoon" analogy may be continued; the slope of the spoon's surface toward the center of the basin is steepest near the back of the spoon, where the handle would join, and shallowest at the tip. In the Illinois Basin, the spoon's tip is in northern Illinois, and the imaginary handle might join the basin near the Williamson County community of Crab Orchard. Thus, the Southern Illinois 208 area may be viewed as Illinois' share of the base of the spoon, where the geological dip of the rocks is relatively steep. The area available for surface and shallow underground mining is therefore restricted by this steepness.

The relative importance of the 208 area's coal resources within the Illinois Basin is significantly increased by three attributes of the coal. First, the major coal seams tend to be thicker in the southern parts of the basin than in the northern. Second, the relative heating value per pound of the coal increases from northwest to southeast. Third, of the limited supplies of low sulfur coal within the state over half are within the Southern Illinois 208 area (see Figure 2). Table 2 shows that the 208 area contains about 17% of Illinois' total coal resources, less than 13% of its surface mineable resources, but about 55% of its low sulfur coal.

The stratigraphically lowest and geologically oldest coal seams in the 208 area outcrop in Pope and Hardin Counties. One of the oldest of these seams, the Reynoldsburg coal, has been mined on only a small scale, but recent tests have shown it to be a high volatile A bituminous coal with good coking properties. Above this coal, in Gallatin County, the Willis coal outcrops. This coal combines good coking properties with a high sulfur content. It has been exploited locally in the past, and there has been some recent interest in its present commercial feasibility as a coking coal. The next major seam above the Willis is the Murphysboro Coal, found only in Jackson and Williamson County. This seam was exploited where its sulfur content was low around Murphysboro prior to 1920. These reserves are depleted, and remaining surface mineable areas have relatively high sulfur content. Reserves of this coal have been mapped south of Crab Orchard Lake, south of Mt. Carbon, north of Oraville, around Ava, and possibly, in the vicinity of Campbell

Figure 2

Location of High Rank and Low Sulfur Coal Resources in Illinois



Sources:

Cady, G. H., Classification and Selection of Illinois Coals, Illinois Geological Survey, Bulletin 62, 1935.

Smith, Wm. H. and John B. Stall, Coal and Water Resources for Coal Conversion in Illinois, Cooperative Resources Report #4, Illinois State Water Survey, Illinois State Geological Survey, 1975.

Table 2

COAL RESOURCES OF THE SOUTHERN ILLINOIS 208 AREA
(MILLIONS OF SHORT TONS)

Area	Seam or Type				Total	Surface Mineable	Less Than 2% Sulphur
	#6	#5	Davis DeKoven	All Other			
Franklin	1,576.754	1,977.950	870.025	65.059	4,489.788	3.019	471.0
Gallatin	827.012	1,298.862	1,507.728	6.892	3,640.494	232.318	0.0
Hamilton	2,273.613	2,192.953	8.893	0.0	4,475.459	0.0	563.0
Hardin	0.0	0.0	3.598	0.0	3.598	0.0	0.0
Jackson	121.804	216.742	0.0	265.758	604.304	361.775	37.0
Jefferson	2,728.518	2,442.508	0.0	25.147	5,196.173	25.147	469.0
Perry	2,031.651	400.565	0.0	0.0	2,432.216	904.339	35.0
Pope	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Saline	1,196.788	917.924	1,828.939	96.254	4,039.905	503.396	623.0
Williamson	613.989	910.562	1,366.827	247.931	3,139.309	589.111	333.0
208 Area	11,370.129	10,358.066	5,586.01	707.041	28,021.246	2,619.105	2,531.0
Illinois	68,747.199	50,620.721	5,881.428	105,315.284	161,817.503	20,426.041	4,611.0
208 Area / Illinois	16.539%	20.462%	94.977%	.671%	17.317%	12.822%	54.890%

Source: Smith, William H. and John B. Stall, Coal and Water Resources for Coal Conversion in Illinois, Illinois State Water Survey, Illinois State Geological Survey, Cooperative Resources Report #4, 1975.
Coal Section Staff, Illinois State Geological Survey, "Illinois" in 1977 Keystone Coal Industry Manual, pp. 592-603.

Hill, where known reserves may represent the Murphysboro coal or the Mt. Rorah seam.[1,2] The reader is referred to Illinois State Geological Survey Circular 260 "Strippable Coals of Illinois, Part 2," by W. H. Smith for the most recent map and description of this coal.

Above the Murphysboro, lie the Davis and Dekoven seams, which are close enough together throughout much of Williamson and Saline Counties to have been strip mined in a double seam operation. In addition to the surface mineable reserves of these seams which form a broad band across Saline and eastern Williamson Counties, there are additional surface mineable reserves in these seams outcropping around the margins of the Eagle Valley Syncline in Gallatin County.

An area of known, but unmapped reserves of Summum, #4 coal straddles the Saline-Williamson County line a few miles north of the Davis-Dekoven outcrops. This area extends east and west from the county line for several miles, and is believed to contain over 150 million tons of mineable coal.[3]

Mining activity in the seams discussed above has been relatively small, and is now restricted to surface mining close to the outcrop of the seam. In the next two seams discussed, the picture is quite different. The Herrin (#6) and Harrisburg-Springfield (#5) seams form nearly continuous layers across the northern half of the 208 area, and have been and continue to be extensively mined by both underground and surface techniques. The importance of these seams in the past has been due to the following attributes: 1) each contains a large area of low to moderate sulfur coal; 2) each contains large, contiguous areas of coal over five feet thick; and 3) in western Perry and eastern Jackson Counties, the two seams are close enough together to be surface mined in the same operation, providing a 9 to 11 foot thickness of coal, or 16,000 to 20,000 tons per acre mined.

The outcrops of the Herrin and Harrisburg-Springfield seams run parallel from the Ohio River west to Crab Orchard in Williamson County. If a line were drawn from Crab Orchard to the northeast corner of Hamilton County east of this line, the Harrisburg-Springfield seam is the more heavily exploited seam with large areas of moderate sulfur content.

From Crab Orchard westward, the two seams' outcrops move northwestward in shallow steps until, in Jackson County, both outcrops turn northward

from DeSoto to the Perry County line along the edge of the DuQuoin monocline.* North of this outcrop area, a historically important region of low sulfur coal occurred in the #6 seam in northwest Williamson, western Franklin, and southwestern Jefferson Counties. This coal has been mined out and most remaining reserves are assigned to existing mines. A few small pockets of reserves exist along the outcrop area, not all of which has lowered sulfur content. In general, in this area the #5 coal has not been exploited, except where it could be surface mined, since the #6 seam is the thicker in most of this area, and the two are probably too close together to make two-seam underground mining possible.

A third clearly defineable region exists from the DuQuoin monocline westwards in Perry County. In this area, the #5 seam is absent or thin except in the western-most townships, where it lies close under the #6 seam. In this area, the dip of both seams away from the outcrop is very low, providing large areas of surface mineable coal which have made Perry County one of the top ten coal producing counties in the U.S.A. About 2/3 of the 208 area's surface mined coal is produced in Perry County.

Both the Herrin and Harrisburg-Springfield seams have been mined by surface and underground methods in the Eagle Valley Syncline in southern Saline and Gallatin Counties. These seams outcrop close to the Davis and Dekoven seams in a U-shaped pattern around the edge of the synclinal valley, and much of the valley is underlain by recoverable #6 and #5 coal. Mapping of this area by public agencies has not been vigorously pursued, with the result that publicly available information about these reserves is scant. All the available data on the coals in this area has been compiled and published in Illinois State Geological Survey Circular 228 and Cooperative Resources Report 4.

Placed 60 to 70 feet above the Herrin seam, and outcropping in line parallel to and a few miles north of the Herrin seam is the Danville, #7 Coal. This is a thin seam in the 208 area, only occasionally exceeding two feet in thickness, restricted to multiple seam surface mines in Saline County.

*Monoclines are folds in rocks similar to a single stair or step. If a line were drawn wouth-southwest from the vicinity of Tamaroa through DuQuoin into Jackson County, rock layers would be found relatively lower on the east or "bottom" of this step-fold than they are on the west or "top."

The Opdyke and related seams occur in east central Jefferson and northwest Hamilton Counties. The Opdyke seam supports a large surface mine near Belle Rive, and the parent company controls reserves in both counties. To date these seams, which seldom surpass 20" in thickness, have seldom been mined at depths over 50 feet.

There are several other seams of local importance or promise; among them are the Gentry, (No. 5A), Onan, Shawneetown, Wise Ridge, and Mt. Rorah seams which have not been mapped by any public agency, and these resources have not been tabulated by county. (Reserves are unknown, but are probably insignificant in terms of production in the 1975-1995 period.)

To summarize the pattern formed by the coal seams in the 208 area, over thirty seams outcrop in mostly parallel bands west from the Ohio River to Perry and Jefferson Counties. Most of these seams are discontinuous in surface mineable thickness, exceptions being the Harrisburg-Springfield #5 seam and the Herrin #6 seam, which are nearly continuous across the area, as well as providing very extensive deep-mineable areas north of their outcrops. Further details descriptive of these resources are provided in Table 3 which shows differences between seams in sulfur, ash, and btu/lb. content.

208 Area Coal Mining Trends, 1956-1975

Total coal production in the 208 area grew to about 150% of the 1956 figure by 1975. This growth was uneven, as annual production figures varied due to strikes, mine openings and closings, and changes in labor productivity. Examination of the production graphs in Figure 3 show that underground production increased rapidly in the late 1960's only to decrease almost as rapidly in the early 1970's to a level almost identical to that of 1956. Conversely, surface production grew to over 200% of 1956 levels, accounting for over 51% of total production in 1975.

Employment figures show a different pattern. While employment has increased in surface mining as production rose, the dramatic changes are in the more labor intensive underground mining, where employment plummeted in the late 50's, then rose rapidly after 1967 (Figure 4).

If one converts surface mine production, employment, and "number of mines" statistics into percentages of their 1956 levels, production has

Table 3
QUALITY OF SOUTHERN ILLINOIS 208 AREA COAL

Seam	Locality	Moisture %	Volatile Matter %	Fixed Carbon %	Ash %	Sulphur %	BTU/LB	Rank Index
Murphysboro	Murphysboro	8-10	33-35	49-53	5-7	0.6-2	12300-12700	130-136
	Carbondale	4-6	33-38	46-52	9-11	3-5	12400-12600	139-143
Davis	Saline County	5-7	35-37	46-48	8-10	3-4	12500-12800	138-143
DeKoven	Saline County	5-7	35-37	46-48	8-13	3-5	11900-12700	138-143
Harrisburg-Springfield #5	Randolph-Perry Counties	8-13	35-38	40-44	9-12	4-5	11000-11400	124-135
	Jackson	8-9	35-36	44-55	11	3-4	11600-11800	130-135
	Gallatin-Saline-Williamson	5-7	33-38	47-53	8-12	2-5	11900-12500	132-141
	Gallatin-Eagle Valley	4-5	34-37	48-52	10-11	3-4	12400-12700	130-147
Herrin #6	Randolph-Perry	8-12	35-39	38-44	9-13	1-4	10800-11300	124-133
	Jefferson-Franklin-Williamson	7-10	32-37	45-50	7-10	1-3	11600-12000	130-135
	Saline-Williamson	4-9	30-36	46-52	7-10	1-3	11700-12300	130-141
	Gallatin-Eagle Valley	3-5	32-35	46-50	10-13	3-4	12400-12700	138-147

Source: Illinois State Geological Survey, "Illinois," in Keystone Coal Industry Manual, 1977, New York, New York: McGraw Hill Book Company, 1977.

Figure 3
Annual Coal Production, Million tons, 1956-1975 for the Southern Illinois 208 Area

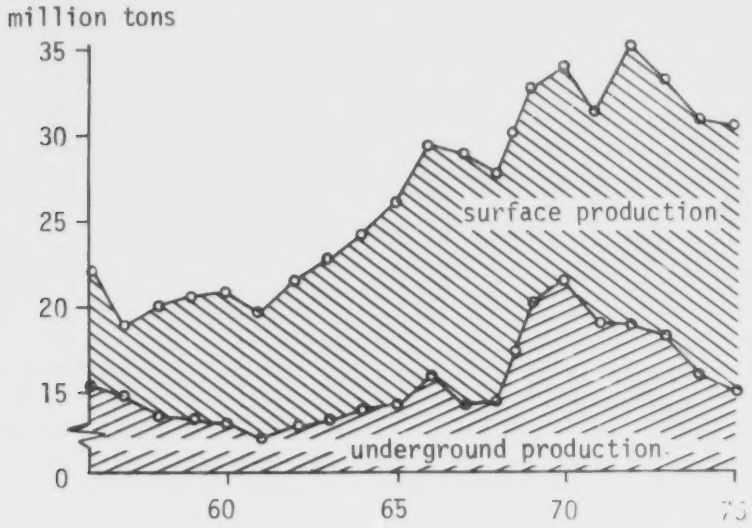
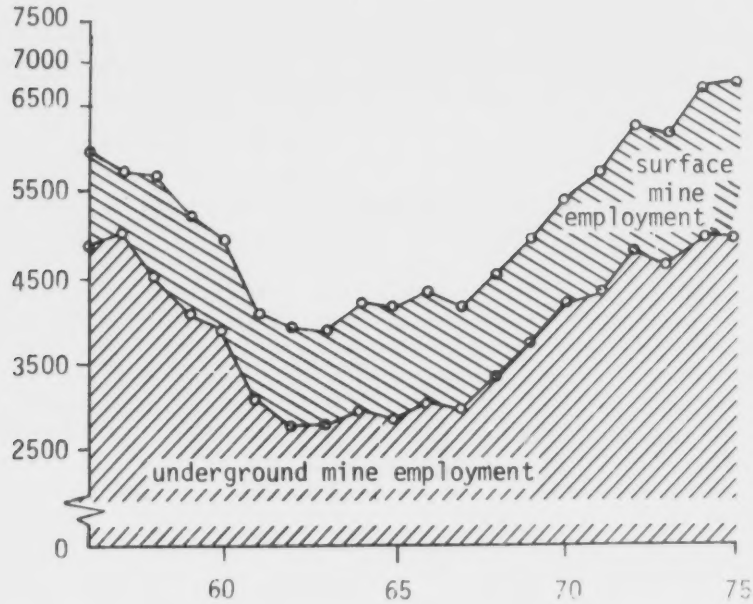


Figure 4
Annual Mining Employment, 1956-1975 for Southern Illinois 208 Area



Source: Illinois State Dept. of Mines & Minerals, Annual Coal Report, 1956-1975.

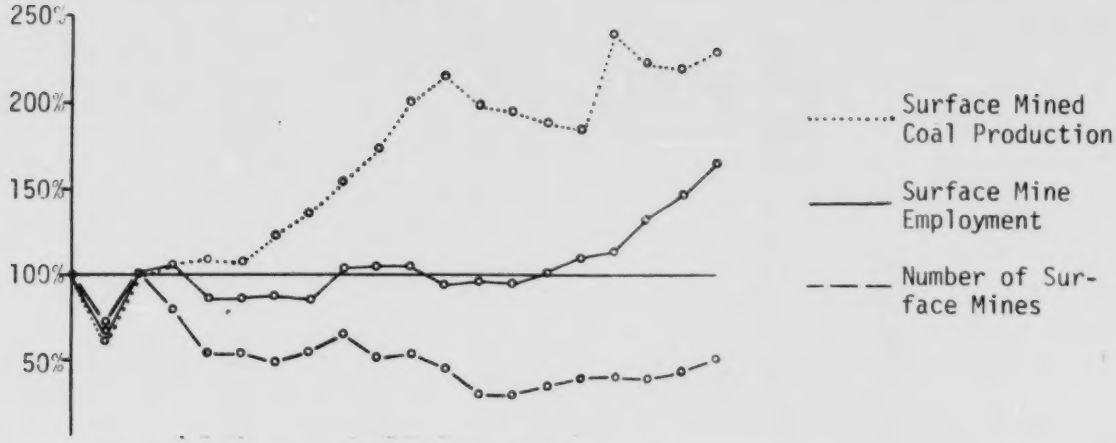
the steepest upward slope, while the number of mines shows a gradual decline (Figure 5). In underground mining, production as a percentage of 1956 data peaks in 1970 and declines thereafter. Employment continues to increase after this downturn, while the number of mines shows a steeper decline than did the number of surface mines (Figure 6).

As one might expect from such figures, labor productivity for both the average surface and underground mines at first holds steady or grows (1956-1965) while average mine size increases rapidly; and then, after 1965 when average mine size increases more slowly, productivity begins to fall dramatically (See Figure 7). Considering the labor intensive nature of the coal industry, it may seem surprising that it could absorb such dramatic losses in production, until recent coal price trends are realized (See Figure 8).

The geographic impact of industry changes can be shown by breaking down production and employment by producing counties. It would be logical to expect each of the coal producing counties to exhibit the overall pattern displayed in region-wide trends. It is of interest, therefore, to note the steady increase of production which is concurrent with an equally steady, but relatively small increase in employment in Perry County (Tables 4a and 4b). During the period 1956-1975, all deep mines in this county closed, but three large new surface mines opened. The trends underline an important point: surface mining is about 1/2 as labor intensive as deep mining. Therefore, swings in production levels have more dramatic socio-economic effect in deep mining regions than in surface mining areas. Also, downward trends in labor productivity can be expected (other effects being equal) to have a less depressive effect on the profitability of surface mining than on deep mining.

We have previously presented an estimate of total coal resources by the Illinois State Geological Survey. Since different states present their resource estimates using varying definitions of resources, they may not be directly comparable. The United States Bureau of Mines has published estimates of demonstrated reserves (a more conservatively defined estimate of reserves than total resources) which are directly comparable across state lines. If one compares figures of reserves and planned additions to annual production capacity with the recent record of mine production, it can be seen that the 208 area's recent production has been higher than its proportionate share of either state or Illinois Basin Reserves would predict (Tables 5a and 5b). At the same time, Table 5b shows that the 208 area has a very much greater than proportionate share of the low to medium sulfur coal available in either the state or the Illinois Basin.

Figure 5

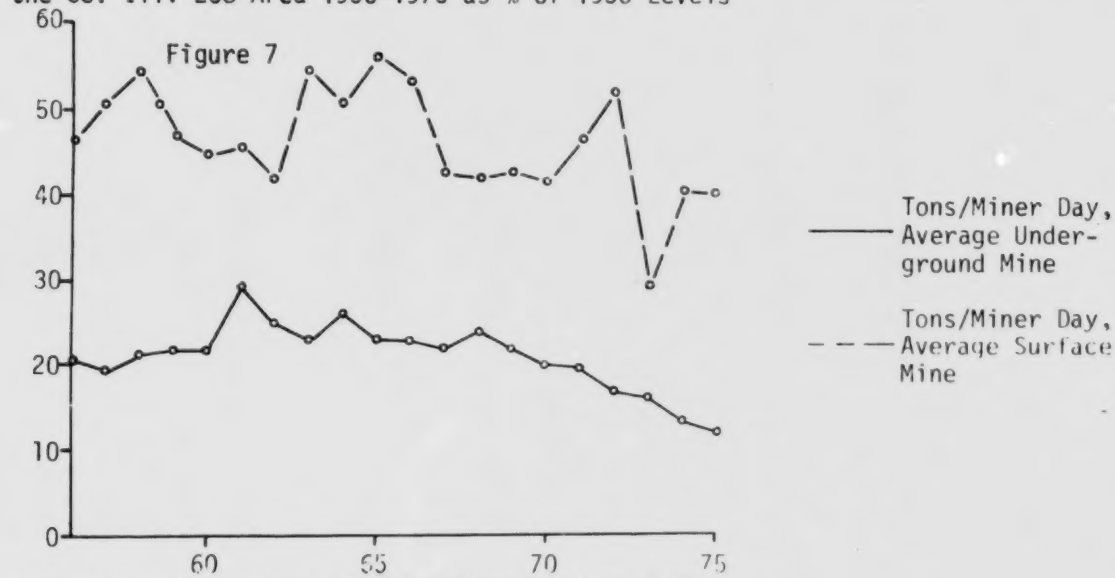


Surface Coal Mine Employment, Production, and No. of Mines in So. Ill. 208 Area 1956-1975 as % of 1956 Levels

Figure 6

Underground Coal Mine Employment, Production, and No. of Mines in the So. Ill. 208 Area 1956-1975 as % of 1956 Levels

Figure 7



Labor Productivity of Surface and Underground Coal Mines in the So. Ill. 208 Area 1956-1975

Source: Illinois State Dept. of Mines & Minerals, Annual Coal Report, 1956-1975.

Table 4a
AVERAGE TONS PRODUCED, 5 YEAR PERIODS 1956-1975, BY COUNTY (000 TONS) (PER YEAR)

County	1956-1960	1961-1965	1966-1970	1970-1975	Average 1956-1975
Franklin	4,545	5,317	7,827	6,320	6,002
Gallatin	159	58	1,420	2,023	915
Jackson	1,242	1,219	351	71	720
Jefferson	2,963	2,688	4,017	6,874	4,135
Perry	3,124	4,012	8,898	10,623	6,664
Saline	2,592	3,407	2,598	2,364	2,740
Williamson	6,043	6,246	5,564	3,650	5,376
TOTAL	20,669	22,947	30,674	31,925	26,554

Table 4b
AVERAGE ANNUAL MINING EMPLOYMENT, 5 YEAR PERIODS 1956-1975, BY COUNTY

County	1956-1960	1961-1965	1966-1970	1970-1975	Average 1956-1975
Franklin	1,515.4	928.4	1,304	1,366.2	1,278.5
Gallatin	76	39	419.2	810.6	336.2
Jackson	341.2	207.4	53.6	19	155.3
Jefferson	685.8	531.6	896.8	1,760.2	968.6
Perry	599.6	337	505.4	941	595.75
Saline	861.2	753.8	598.2	623.2	709.1
Williamson	1,658.4	1,361.4	1,041.4	936.0	1,249.3
TOTAL	5,737.6	4,258.6	4,818.6	6,456.2	5,292.75

Source: Illinois Department of Mines and Minerals Annual Coal Report, 1956-1975.

Table 5a
RELATIVE TOTAL PRODUCTION AND SURFACE PRODUCTION
FOR THE SOUTHERN ILLINOIS 208 AREA, ILLINOIS,
AND THE ILLINOIS BASIN, 1963-1976

	Illinois Basin		Illinois		208 Area		Total Production, 208 Area	
Year	Total Production	% By Strip Mining	Total Production	% By Strip Mining	Total Production	% By Strip Mining	As % of Illinois	As % of Illinois Basin
1963	102.552	59.6	51.736	52.7	22.372	41.95	46	22
1964	107.954	61.9	55.023	54.5	23.927	43.79	46	22
1965	113.247	63.2	58.483	55.9	25.521	45.51	46	23
1966	123.087	61.5	63.571	56.8	29.033	46.99	49	24
1967	130.295	64.9	65.133	57.1	28.440	51.00	47	22
1968	127.442	63.4	62.441	57.7	27.469	48.87	48	22
1969	132.274	60.7	64.772	53.5	32.280	41.19	50	24
1970	140.185	61.6	65.119	50.7	33.594	38.08	52	24
1971	127.617	63.0	58.402	49.6	31.133	40.06	53	24
1972	143.802	63.9	65.523	51.6	34.827	46.87	53	24
1973	140.504	60.4	61.572	47.1	32.933	45.94	54	23
1974	133.783	59.3	58.216	46.3	30.676	48.62	53	23
1975	141.077	59.5	59.537	46.5	30.130	51.76	51	21
1976	133.089	n/a	58.136	46.9	29.162	54.30	50	22

NOTE: Tonnage figures in millions of short tons.

Source: Malhotra, Ramesh, Market Potential for Coals of the Illinois Basin, Illinois Mineral Note #67, Illinois State Geological Survey, August, 1977.

Illinois State Department of Mines and Minerals, Annual Coal Report, 1963-1976.

Table 5b
DEMONSTRATED COAL RESERVES AND ANNOUNCED NEW CAPACITY BY 1985
FOR THE ILLINOIS BASIN, ILLINOIS AND THE SOUTHERN ILLINOIS 208 AREA

Millions of Tons	Illinois Basin	Illinois	208 Area	208 Area As % of Illinois	208 Area As % of Illinois Basin
Strippable Reserves	17,800.96	12,222.86	2,464.36	20.16%	13.84%
Strippable Reserves Less than 2.7% Sulfur	1,535.90	923.61	641.28	69.43%	41.79%
Deep Reserves	71,110.24	53,441.86	14,594.44	27.31%	20.52%
Deep Reserves Less than 2.7% Sulfur	7,934.08	5,381.82	4,656.94	86.53%	58.70%
Total Reserves	88,911.20	65,664.72	17,058.80	25.98%	19.19%
Total Reserves Less than 2.7% Sulfur	9,469.98	6,305.43	5,298.22	84.03%	55.95%
Announced New Capacity by 1985					
STRIP	19.80	10.2	7.9	77.45%	39.90%
DEEP	24.35	21.6	8.5	39.35%	34.91%
TOTAL	44.15	31.8	16.4	51.57%	37.15%

Source: Neilson, George F., "Coal Mine Development and Expansion Survey," 1977 Keystone Coal Industry Annual, McGraw Hill, Inc., pp. 760-764.

Thompson, Robert D. and Harold F. York, The Reserve Base of U.S. Coals By Sulfur Content, 1. The Eastern States, U.S. Department of Interior, U.S. Bureau of Mines Information Circular 8680, 1974.

It is fair to conclude that the comparatively high rate of reserve exploitation is partly due to the relatively good quality of 208 area coal. 208 area coal tends to be higher in btu content and lower in sulfur than other Illinois mine products.

We may summarize by stating that the southern Illinois 208 area's coal production forms a higher proportion of the state's and the Illinois Basin's production than the area's total resource tonnage would lead one to expect. We have seen that the area is blessed with relatively thick coal deposits in the major seams, and that these areas are frequently above average in heating value and lower in sulfur. These qualities in southern Illinois coal have helped support a fairly static level of exploitation by underground mining, which has focused on thick low-sulfur deposits. Strip mining has undergone concentration in the last two decades as mine sizes have increased, and production has increased dramatically, especially from the double seam area of western Perry County. Despite rapid expansion of surface mined tonnage, total employment at first decreased, and then exhibited a moderate increase in response to declines in deep mining, increased mechanization of both surface and deep mines.

There is no question that the 208 area's coal reserves are physically adequate to support almost any currently projected level of expanded production. The U.S. Bureau of Mines estimates total reserves at over 17 billion tons. Present production of 30 million tons per year reduces these reserves by less than 1/3 of 1% per year. Understanding of likely future levels of coal industry development rests in turn upon understanding of forces affecting demand for the area's coal. The second chapter of this report provides an analysis of future demand for the area's coal.

Explanation of the Use of the Terms Reserves and Resources in this Report

The term coal resources is used in this report in the sense of identified resources, i.e., "specific bodies of coal whose location, quality, and quantity are known from geologic evidence."[4] The Illinois State Geological Survey estimates Illinois' resources at 161.8 billion tons of coal.[5]

The term reserves is usually restricted to coal whose qualities and quantity are more intimately known than is usually the case for resources. Reserves form part of resources. Thus reserves focus on coal which will usually (but not always) be exploited before less well-known resources. A fairly conservative usage of reserves is the U.S. Bureau of Mines category demonstrated reserves, which includes "measured" and "indicated" reserves, i.e., coal known from direct observations less than or equal to 1½ miles apart (such observations may include mines, wells, or other drill cores, and outcrops).[6] The U.S. Bureau of Mines estimates Illinois' demonstrated reserves at 65.7 billion tons.[7]

The term reserves is also used in this report, especially in Chapter 3 to designate various sub-categories of the coal resources which it is predicted are most likely to be exploited before 1995. The term is also used in Chapter 3 in discussing the reserve block, or required contiguous demonstrated reserves of coal necessary to support a mine with a given annual production capacity for an indicated term of years.

FOOTNOTES FOR CHAPTER 1

[1]Cady, Gilbert H. Mineable Coal Reserves of Illinois. Illinois State Geological Survey Bulletin #78, 1952, p. 47.

[2]Willman, H. B. Handbook of Illinois Stratigraphy. Illinois State Geological Survey Bulletin #95. (Urbana, Illinois, Illinois State Geological Survey, 1975).

[3]Federal Systems Division, I.B.M., Illinois Coal Study, 1970.

[4]Allgaier, G. J., and Hopkins, M. E. Reserves of the Herrin (#6) Coal in the Fairfield Basin in Southeastern Illinois. Illinois State Geological Survey Circular 489 (Urbana, Illinois, State of Illinois, Department of Registration and Education, 1975), pp. 18-19.

[5]Smith, W. H., and Stall, John B. Coal and Water Resources for Coal Conversion in Illinois, Cooperative Resources Report #4, Illinois State Water Survey, Illinois State Geological Survey (Urbana, Illinois: State of Illinois Department of Registration and Education, 1975).

[6]Staff, Eastern Field Operations Center, Mineral Supply, The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States, Information Circular 8655 (Pittsburgh, Pennsylvania: United States Department of Interior, Bureau of Mines, 1974), pp. 3-5.

[7]Thompson, Robert D., and York, Harold F. The Reserve Base of U.S. Coals by Sulfur Content, 1. The Eastern States, Information Circular 8680 (Washington, D.C.: U.S. Department of Interior, Bureau of Mines, 1974).

Chapter 2

DEMAND FOR 208 AREA COAL

Review of Pertinent Forecasts

Numerous forecasts of future coal production in Illinois or the Illinois Basin have been made in recent years, however, few forecasts go beyond 1985, and the local, specific mine expansion plans are considered proprietary, and are released only 1 to 5 years in advance of mine openings. Additionally, the recent federal and state regulatory policy changes have upset normal market processes and added much uncertainty to the future of the mid-western coal industry. Commonwealth Edison recently developed a steam coal forecast, of which its author said, "Never has it been so difficult to predict what lies in the future and to prepare for what one does forecast."[1]

Demand for 208 area coal is not wholly derived from the demand for electricity. Significant percentages of current coal production are dedicated to the industrial and coking coal markets. While no coal is currently mined for synthetic fuel production, such a sector is likely to develop. Unfortunately, few state or Illinois Basin forecasts consider these subsections of total production independently in their published figures. Table 6 shows 16 projections of Illinois Basin and State coal production. Forecasts for the State of Illinois tend to be older, and show higher annual growth rates than those for the Illinois Basin. Note that of all these forecasts, only one (A.II.) explicitly predicts demand formation due to synthetic fuel production.

Three forecasts, AI, AII, and AV, forecast for subsectors of the total Illinois Basin Industry, (as shown in Table 6.)

The Influence of Sulfur Content on Future Marketability of 208 Area Steam Coals

U.S.E.P.A. is instituting a New Source Performance Standard (NSPS) of 1.2 lbs. SO_2 per million Btu of heat input on all new major coal burn-

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Table 6
FORECASTS OF ILLINOIS BASIN COAL PRODUCTION
(Production in Millions of Tons Per Year)

Source	Scenario Name	1975	1976	1980	1981	1985	1990
A.	Utility Coal	125	-	-	-	193	-
B.	Utility Coal	125	-	-	-	185	-
	Industrial Coal	11	-	-	-	17	-
	Coking Coal	4.3	-	-	-	10	-
	Synthetic Fuel	0.0	-	-	-	3	-
	Total	140.3	-	-	-	215	-
C.	Cleaner Coal	141	-	-	-	196	-
	Reference	141	-	143	-	179	194
D.	New Source Performance Standard	141	-	-	-	-	189
	Scrubbers and No New Oil	141	-	-	-	-	221
E.	Utility Coal	-	117	-	119	142	-
	Industrial Coal	-	10	-	12	13	-
	Coking Coal		4	-	4	5	-
	Total	-	131	-	135	160	-
F.	Reference	141	-	96	-	156	176
G.	New Capacity Survey	141	133	148	-	197	200

Sources:

A. Lundgren, R.M., in Prouty, Dick, "Production Shortfall is seen as certain in the 1980's," Coal Mining and Processing, V. 14, #4, April 1977.
B. Malhotra, Ramesh, Market Potential for Illinois Basin Coal, Illinois Minerals Note #67, Illinois State Geological Survey, August 1977.
C. Federal Energy Administration, 1977 National Energy Outlook, Draft (Washington, D.C., 1977).
D. I.C.F. Incorporated, "Issues and Impacts Associated with Proposed Prevention of Significant Deterioration and Non-Attainment Amendments to the Clean Air Act, Executive Summary" (Washington, D.C., I.C.F. Inc., May 12, 1976).
E. Johnston, Verl, "Coal Demand Through 1985," paper presented at the 1977 National Coal Association/Bituminous Coal Research Convention, Louisville, Kentucky, October 16-18, 1977.
F. Federal Energy Administration, National Energy Outlook, February 1976 (Washington, D.C., February 1976).
G. Greater Egypt Regional Planning and Development Commission staff.

ing facilities, especially large power plants. It is possible that a further standard of 1.8 lbs. SO_2 emitted per million Btu of heat input will be imposed on existing sources and on smaller new sources. One pound of sulfur burned at 95% combustion efficiency (the usual engineering assumption) produces 1.9 lbs. of SO_2. Thus, coal input to furnaces allowed, for example, 1.2, 1.8, or 6.0 lbs. of SO_2 output per million Btu input must contain less then .63%, .95%, and 3.16% lbs. of sulfur per million Btu respectively. The 208 area coal cannot meet 1.2 or 1.8 standards in its raw state. Area "low sulfur" coal is currently cleaned to, or nearly to, the 1.8 lbs. sulfur/million Btu level, and recycled wastes from abandoned area mines (gob) can meet this standard (Table 7). These categories comprise only about one third of area production. At first glance, it would seem that 67% of the area's industry, including all strip mining, would be shut down by new sulfur dioxide emission standards. This will not occur for several reasons.

Table 7
QUALITY OF COAL SOLD IN 1977 BY 208 AREA MINES

Source/Quality	Million Btu/Ton	Lbs. Sulfur/ Million Btu	Ash %	Estimated 1980 Price: $/Million Btu	Estimated % of Tonnage Total Mined
Low Sulfur Deep Mines (average of 5 of 6 such mines)	23.72	1.26	7.59	.92	23.2
High Sulfur Deep Mines (average of 5 of 5 such mines)	22.81	2.34	10.85	.84	20.5
Large Surface Mines (average of 10 of 11 such mines)	22.43	2.73	10.69	.69	50.4
"Spot" (average of 2 of 6-15 small surface mines and one small deep mine)	22.12	3.47	15.00	.76	4.8
Recycled "Gob"	24.00	.83	n/a	1.04	1.1

Note: No transportation cost is included; the cost of cleaning as required by contract is included. This implies, on the average, a 20% reduction in sulfur content, an estimated 8% gain in Btu/ton, and a 20% reduction of volume. For example, 2000 lbs. of 24 million Btu/ton

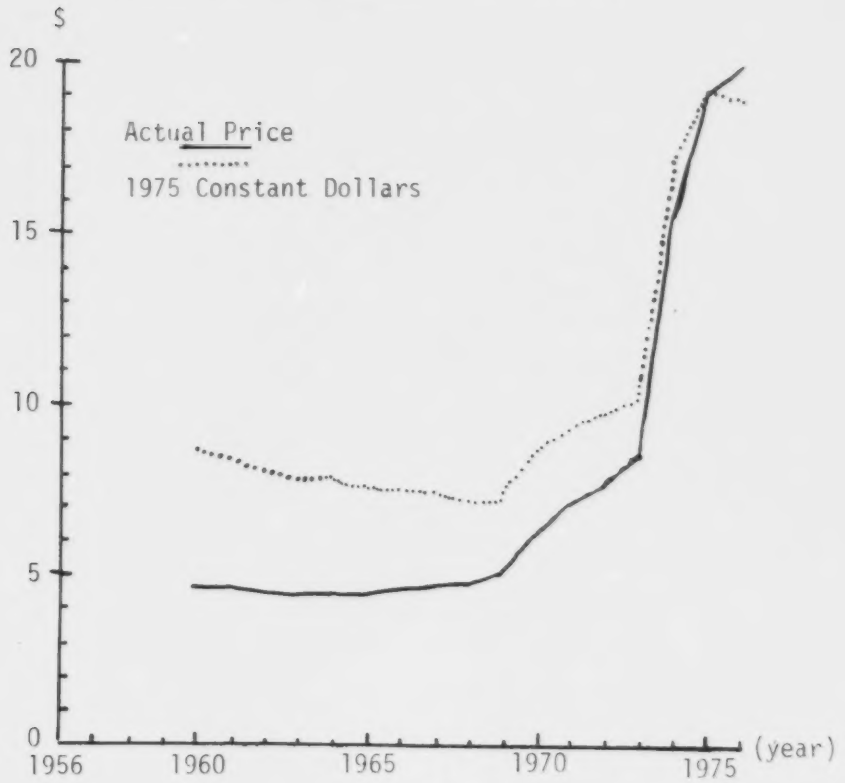
coal with 2% sulfur as received is cleanable to 1600 lbs. of 25.95 million Btu/ton coal with 1.60% sulfur. Costs include the mining cost of the 20% lost in cleaning and estimated labor cost increase.

Source: Coal Outlook, reprinted F.E.R.C. form 423 data, Jan. - Aug., 1977.

Primary among these reasons, is President Carter's proposed Energy Plan, which will require all new coal burning plants to adopt "Best Available Control Technology" (BACT) to reduce sulfur oxide emissions.[2] Coal which can be burned in compliance with new air pollution regulations is concentrated in the sub-bitumious field of New Mexico-Arizona; the bituminous field of Utah; Colorado; the Northern Great Plains; the Oklahoma-Arkansas field; and the Central Appalachian field of West Virginia, Eastern Kentucky, and Virginia (much North Dakota lignite is not "compliance" coal because of its low Btu content), while demand is centered east of the Mississippi, solving the emission dilemma by shipping "compliance coal" thousands of miles is frequently not desirable. An alternative to shipping compliance coal long distances is the desulfurization of furnace-flue gases by "scrubbers," which remove SO_2 from waste gases. Two basic types of scrubbers exist: regenerative and non-regenerative. Regenerative scrubbers reconstruct elemental sulfur or sulfuric acid from SO_2 and produce no sludges. However, these processes are generally more expensive than sludge-producing non-regenerative scrubbers (unless sludges cannot be disposed of on site, and even if sulfur and sulfuric acid produced are sold). At present, non-regenerative scrubbers appear more reliable, as well. Non-regenerative scrubbers can remove 90-95% of sulfur oxide from stack gases, at a cost which varies directly with the sulfur content of input fuel. The relationship between sulfur in coal and scrubbing cost is not linear (See Figure 9). Available data on scrubbing costs for midwestern utilities suggests that these costs will rise from a minimum of $.09 per million Btu for coal with less than 1% sulfur to about $.18 per million Btu at 1.5% sulfur. Thereafter costs rise more gradually for new units, reaching about $.30 per million Btu for coal with 4.5% sulfur.[3]

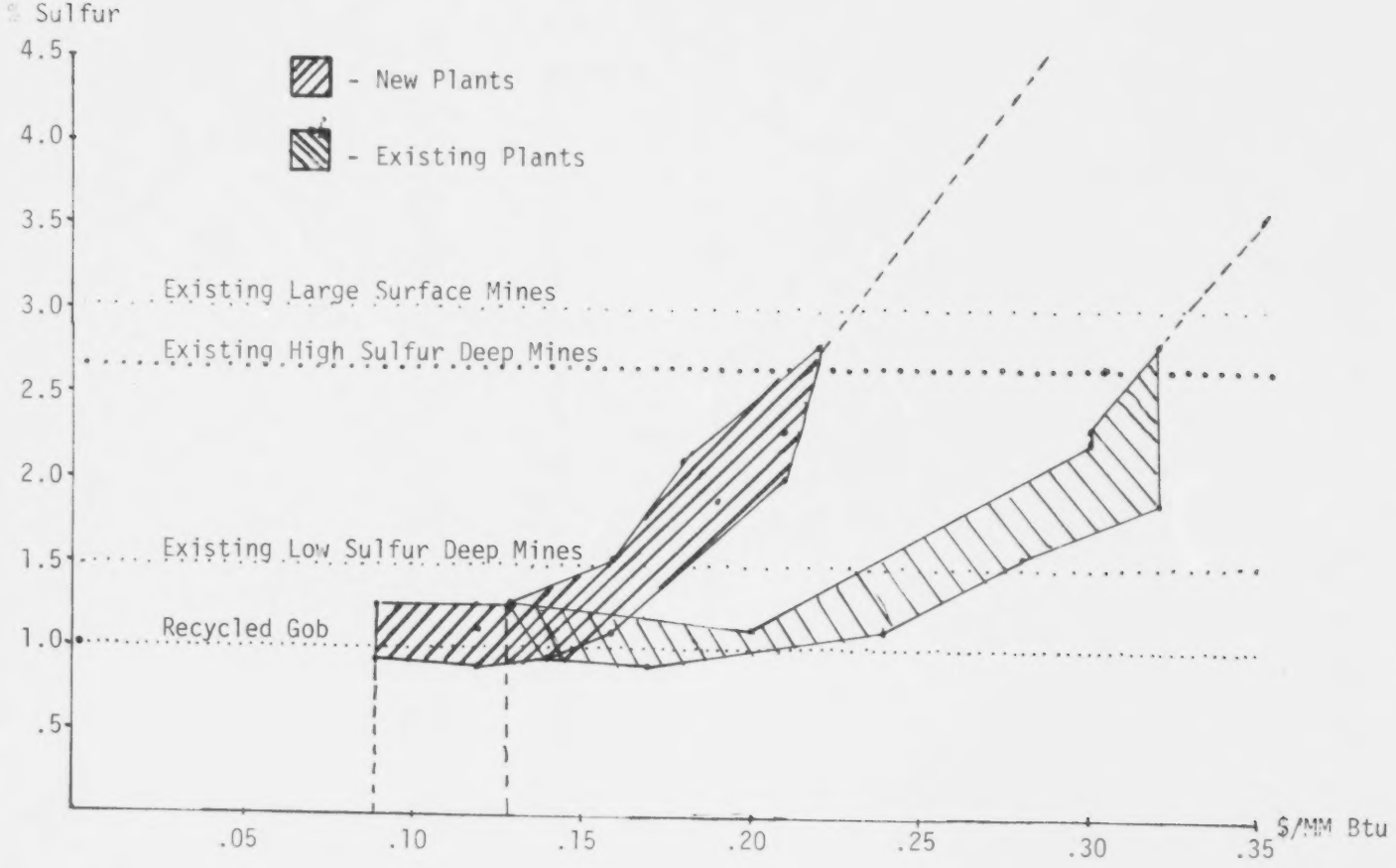
The sulfur content of steam coal can be and usually is reduced at the mine through physical cleaning by crushing the coal and using methods of separation which employ differences in specific gravity between coal and incorporated impurities. These methods were originally developed to remove ash from coal, but can be used with varying effectiveness to remove heavy minerals, such as iron pyrites, from coal. The effectiveness of such methods varies with the type of sulfur in a given coal. Many Appalachian coals are high in pyritic sulfur and low in organic sulfur, and elaborate physical cleaning methods have proven cost effective in greatly reducing sulfur content. Midwestern coals typically contain higher amounts of organic sulfur, as well as pyritic sulfur

Figure 8
AVERAGE PRICE PER TON OF COAL FOB MINE
IN ACTUAL AND CONSTANT 1975 DOLLARS



Source: Federal Energy Administration, Energy in Focus: Basic Data, Advance Copy (Washington, D.C.: U.S.G.P.O., April, 1977).

Figure 9
SCRUBBING COSTS FOR 208 AREA MINE PRODUCTS



Note: Scrubbing costs for mid-continent utilities meeting emission standards of 1.2 & 1.6 lbs SO_2/mm Btu of Coal input

Source: Modified from Hoffman, Lawrence, S.J. Aresco, and Elmer C. Holt, "Engineering/Economic Analyses of Coal Preparation with SO_2 Clean-Up Processes for Keeping Higher Sulfur Coals in the Energy Market," paper presented at the Second Symposium on Coal Preparation, NCA/BCR Coal Conference and Expo II, October 19-21, 1975, Louisville, Kentucky.

disseminated in very fine particles.[4] While over 40% of total sulfur can occasionally be removed from 208 area coal, 20% reduction in total sulfur is a more common result.[5] Further, it is precisely those coals naturally low in sulfur which are the hardest to clean. Thus a 4% sulfur coal may be cleanable to about 3% sulfur at a cost of $.03-$.09 per million Btu, but it may not prove feasible to clean a 1.5% sulfur coal to a level below 1.25-1.3% sulfur by weight. Stack gas scrubbing, while expensive, is such a relatively efficient method of sulfur removal that it tends to economically dominate all but the coarsest beneficiation of midwestern steam coals through physical cleaning.

Several conclusions and questions follow from this realization: 1.) scrubbing costs vary with sulfur content, and are not very effectively reduced by physical cleaning of midwestern coals; 2.) scrubbing costs are $.08 to $.32 per million Btu, as compared to coal costs F.O.B. the 208 area mine of $.69-$1.04 per million Btu; and 3.) mining costs per million Btu tend to be higher than 208 area costs in those producing regions east of the 208 area, and lower west of the 208 area. Therefore, if stack gas scrubbing is mandatory, regardless of coal sulfur content, markets for 208 area coal will be more strongly influenced by variations in regional coal mining costs than by costs of sulfur reduction. If the likely future market area for 208 area coal is to be analyzed, total mining costs and transportation costs must be considered as well as sulfur reduction costs.

Present and Future Market Regions for 208 Area Steam Coal

The present sales region for 208 area steam coal can be determined from published data based upon the utilities F.E.R.C. form 423, which lists buyers and sellers of steam coal, tonnages, Btu, ash, and sulfur characteristics of the coal included as well as the delivered price. To provide a set of interpoint transport costs, we have employed the railroad costs used by Malhotra.[6] For each regional coal product used by Malhotra, a scrubbing cost has been added based on the assumed Btu and sulfur content of the coal after physical cleaning. Thus, Btu contents for regional steam products are slightly increased to reflect minehead physical cleaning while scrubbing costs are slightly reduced by this process.

Malhotra's rail costs, if expressed in linear form, would approximate the equation:

$$TC = \$2.74 + (\$.0076)(m)$$

where $2.74 is the fixed loading and unloading cost and (.0076) represents a variable cost per ton mile (m), and TC is total transport cost. Malhotra's costs do not appear to fully reflect achievable savings through use of unit trains, nor do they appear to reflect barge rates for appropriate transport links.[7] Since no link-specific barge or unit-train costs were available for this analysis, Malhotra's rates were used. An additional production centroid for 208 area steam coal at West Frankfort was added to those used by Malhotra, and in effect, his analysis of delivered costs for steam coal was "rerun" with the following modifications:

1.) Delivered cost includes estimated scrubbing costs (from Figure 9).

2.) Btu values of regional coal products were altered to reflect minehead cleaning.

3.) Sulfur values input into the analyses were estimated to reflect delivered product levels.

4.) Fifteen of the twenty-one destinations used by Malhotra were employed for analyses; all of Malhotra's shipping regions were used, plus a new "208 area" region.

5.) Surface mine costs for all regions were increased 10%/million Btu from those shown by Malhotra to reflect additional real costs imposed by P.L. 95-87 by 1980.[8,9] (It should be noted that states with weak laws will experience a greater percentage increase. Illinois is classified as a state with a strong law.)

The input values for Btu level, sulfur level, minehead price, scrubbing cost, and total cost without transportation are shown in Table 8. When the values computed for Table 8 are added to rail transport costs, a matrix representing not only the delivered cost of coal which has been physcially cleaned at the mine, but additionally, the cost of stack gas scrubbing results (Table 9). A first glance at Table 8 shows 208 area steam coal to be the cheapest fuel source only in St. Louis and Cincinnati. However, it is closely competitive in Detroit, Little Rock, Yazoo City, Tampa, Atlanta, Indianapolis, and Chicago. The importance of second and third place finishes in the price competition is more easily understood when several additional factors are considered.

First, most western surface mines are large and new, operating close to the minimum cost available through economies of scale.[10] There is thus less variation about the average of estimated costs for western surface mines than there is for eastern mines. Most large existing 208 area surface mines operate at smaller scales which are not yet dictated by

Table 8
VALUES INPUT INTO GERP&DC ANALYSIS OF 208 AREA STEAM COAL MARKET

Region & Type	Estimated Million btu/ton	Estimated Cost Of Scrubbing to NSPS ($)	Cost FOB Mine/Million btu ($)	Sulfur,% By Weight	Cost FOB Mine/Ton ($)	Total Cost Million btu Without Transport ($)
S.Illinois						
Surface	22.4	.23	.785	2.9	17.58	1.015
Deep	23.9	.22	.837	2.6	20.00	1.057
N.Illinois						
Surface	22.2	.25	.843	3.4	18.71	1.093
Deep	23.7	.24	.844	3.1	20.00	1.084
W.Kentucky						
Surface	22.8	.24	.821	3.2	18.72	1.061
Deep	24.3	.23	.823	2.9	20.00	1.053
Indiana						
Surface	22.5	.23	.831	3.0	18.70	1.061
Deep	24.0	.22	.833	2.7	20.00	1.053
E.Kentucky						
Surface	24.5	.16	.898	1.3	22.00	1.058
Deep	26.0	.13	.962	1.2	25.00	1.092
W.Virginia						
Surface	24.2	.19	1.136	1.9	27.49	1.326
Deep	25.7	.18	1.167	1.7	30.00	1.347

Table 8 - Continued

Region & Type	Estimated Million btu/ton	Estimated Cost Of Scrubbing to NSPS ($)	Cost FOB Mine/Million btu ($)	Sulfur,% By Weight	Cost FOB Mine/Ton ($)	Total Cost Million btu Without Transport ($)
Ohio						
Surface	22.9	.23	.865	3.0	19.81	1.095
Deep	24.4	.22	1.025	2.7	25.00	1.245
Colorado						
Surface	22.8	.09	.724	.6	16.51	.814
Deep	24.3	.09	1.193	.5	29.00	1.283
Montana						
Surface	18.0	.09	.550	.6	9.90	.64
Deep	19.5	.09	1.026	.5	20.00	1.116
Wyoming						
Surface	19.3	.13	.570	1.1	11.00	.70
Deep	20.8	.12	.962	1.0	20.00	1.082
New Mexico						
Surface	22.8	.09	.647	.7	14.75	.737
Deep	24.3	.09	1.235	.6	30.00	1.325

NOTE: See discussion in text.

SOURCES: as in footnotes 4, 5, 6, 7, and Editors of Coal Outlook, reprints of FERC form 423 Jan - August, 1977.

Phillips,Peter J. and Paul P. DeRienzo "Assessing The Economics of Steam Coal Preparation," Coal Mining and Processing, Sept. 1977.

Table 9
COST OF BURNING STEAM COAL TO MEET
A NEW SOURCE PERFORMANCE STANDARD OF
1.2 lbs. SO_2/million btu ($/million btu)

	West Frankfort Illinois		Mt. Vernon Illinois		Rockport W Kentucky		Vincennes Indiana		Hazard E Kentucky	
At/From	Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep
Chicago	1.26	1.28	1.33	1.32	1.29	1.36	1.31	1.29	-	-
Indianapolis	1.25	1.28	1.33	1.31	1.32	1.29	1.25	1.23	1.26	1.28
Kansas City	1.26	1.28	1.33	1.30	1.32	1.31	1.31	1.29	-	-
St. Louis	1.17	1.20	1.24	1.23	1.30	1.27	1.30	1.24	-	-
Atlanta	1.31	1.33	1.40	1.37	1.30	1.27	1.32	1.30	-	-
Greenbay	1.31	1.33	1.38	1.35	1.33	1.32	1.32	1.30	-	-
Tampa	1.43	1.45	1.52	1.49	1.43	1.40	1.47	1.44	-	-
Yazoo City	1.27	1.30	1.36	1.34	1.38	1.35	1.33	1.31	-	-
Ft. Worth	1.37	1.39	1.47	1.43	1.42	1.39	1.45	1.42	-	-
Houston	1.42	1.43	1.51	1.47	1.46	1.40	1.44	1.41	-	-
Little Rock	1.26	1.29	1.35	1.33	1.32	1.30	1.39	1.32	-	-
Oklahoma Cty	1.32	1.34	1.41	1.38	1.40	1.37	1.40	1.37	-	-
Muscogee	1.29	1.32	1.38	1.35	1.38	1.35	1.36	1.34	-	-
Cincinnati	1.23	1.26	1.31	1.29	1.32	1.30	1.27	1.26	1.28	1.30
Detroit	1.31	1.34	1.39	1.35	1.32	1.30	1.29	1.27	1.30	1.31

Sources: Same as for Table 8, railroad rates as in Malhotra, Ramesh, Market Potential for Coals of the Illinois Basin, Illinois Mineral Note 67 (Urbana, Illinois, Illinois State Geological Survey, August 1977).

Table 9 (cont'd)

Wierton W Virginia		Urichsville Ohio		Grand Junction Colorado		Billings Montana		Casper Wyoming		Black Mesa New Mexico	
Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep	Surface	Deep
-	-	-	-	1.30	1.74	1.23	1.67	1.26	1.66	1.28	1.83
1.53	1.72	1.31	1.45	1.33	1.77	1.30	1.77	1.29	1.69	1.36	1.91
-	-	-	-	1.21	1.64	1.16	1.59	1.19	1.49	1.17	1.73
-	-	-	-	1.27	1.72	1.24	1.67	1.22	1.61	1.31	1.85
-	-	1.39	1.52	1.39	1.82	1.39	1.82	1.39	1.77	-	-
-	-	-	-	1.32	1.76	1.17	1.64	1.28	1.68	1.38	1.93
-	-	1.52	1.65	1.50	1.93	1.56	1.95	1.52	1.90	-	-
-	-	1.42	1.56	1.22	1.66	1.39	1.81	1.33	1.72	-	-
-	-	-	-	1.21	1.65	1.03	1.68	1.18	1.56	1.12	1.69
-	-	-	-	1.28	1.72	1.35	1.77	1.36	1.63	1.19	1.74
-	-	-	-	1.29	1.73	1.39	1.81	1.29	1.67	1.22	1.79
-	-	-	-	1.22	1.66	1.28	1.71	1.19	1.57	1.14	1.71
-	-	-	-	1.18	1.62	1.28	1.71	1.20	1.58	1.17	1.74
1.57	1.76	1.33	1.47	1.37	1.80	1.33	1.78	1.32	1.71	-	-
1.56	1.75	1.36	1.49	1.37	1.80	1.33	1.76	1.32	1.72	-	-

available reserves, and their production could be (and is being) expanded with conseouent cost and price reductions.[11] F.E.R.C. form 423 reprints show several newer 208 area surface mines to be delivering coal in eastern Missouri at lower prices than neighboring older mines delivering coal comparable in ash, sulfur, and Btu content.[12]

As stated above, transport costs used in this analysis do not reflect savings available to 208 area producers who can ship by unit train or conveyor to coal loading facilities such as those at Cora or Kellogg on the Mississippi, or Shawneetown on the Ohio, and then utilize barge transport to the lower Mississippi, the Gulf Coast, or urban centers on the upper Mississippi and Illinois waterway. These savings could bring 208 area mines a larger market share than Table 9 suggests.

Further, as argued by Malhotra, both western and Appalachian low sulfur coals are available in limited supply (a statement the Surface Mining Research library, Charleston, West Virginia, disagrees with).[13] Much western low sulfur coal is not competitive in mid-continent markets.

Further data, however, related to transportation costs, availability of Appalachian low-sulfur coal, and the ability of some Appalachian coal to meet "new source" levels either "as mined" or when washed, is needed in order to confirm these statements. Further, the low sulfur Kanawha River (Charleston), West Virginia area should be considered as a coal shipping point as well as the high sulfur Weirton area. Overall, it is assumed that 208 area coal may be competitive wherever it is second only to Appalachian low sulfur coal or western coal, if it is within three cents per million Btu of the lowest priced fuel source. These assumptions lead to the conclusions graphically displayed in Figure 10. This map indicates that the 208 area will lose some important existing market areas for steam coal in Iowa, Minnesota, Wisconsin, and Michigan, but will regain access to the metropolitan Chicago area, and possibly, some areas in Ohio and Indiana. To the south, where data points are scarce, it appears that 208 area coal may gain access to emerging steam coal markets in Mississippi, Georgia, Arkansas, Alabama, and Louisiana. These areas have hitherto relied upon gas and oil for electricity generation, sources which are not likely to be available to new plants in 1985 due to federal policy of reducing utility reliance on imported fuels.[14]

As readers will recall from the many forecasts reviewed in Table 6, some analysts (in reviewing data similar to that presented in this section, but on a broader scale) have concluded that Illinois Basin steam coals

Figure 10
DELIVERIES OF SOUTHERN ILLINOIS 208 AREA STEAM COAL IN 1975 AND 1977; POTENTIAL NEW MARKETS BY 1980 AND 1985

1975 Deliveries

1977 Deliveries

1978-80 New Coal-fired Utility Plants.

1981-85 New Coal-fired Utility Plants

Note: To reach forecast steam coal production levels, 208 mines must supply 60 to 75% of these new plants.

Sources:

1) Wilkey, Michael L., and Charles M. Macal, Coal Blending in Illinois, Energy and Environmental Systems Division, Argonne National Laboratory, State of Illinois Institute for Environmental Quality, April 1976.

2) Editors, Coal Outlook, February - December 1977.

3) Benson, David C. and Frank J. Doyle, Projects to Expand Fuel Sources in Eastern States - An Update, Information Circular 8765, U.S. Bureau of Mines, 1978.

4) Berge, John S., Doyle L. Olson, and Gregory B. Taylor, 1976 Coal-Uranium Energy Resources (Denver, Col., Berge Exploration, Inc., 1976).

face an extremely promising future. Review of transport modes and costs suggests that the sub-regions most likely to profit from these opportunities are West Kentucky and Southern Illinois. While GERP&DC staff concur in these conclusions, the amount of industry growth to be expected within the ten Southern Illinois 208 Counties depends upon the degree to which the area's reserves (both surface and underground) can be produced at prices competitive with those of other Illinois Basin producing sectors. While examination of 208 area coal reserves is reserved for the following chapter, it can be said that the degree to which economically attractive Illinois reserves are centered in the 208 area is somewhat less than in past periods, thus the 208 area's share of the Illinois Basin's coal production may gradually decline, even while total production is expanding. Much will depend on factors such as relative labor productivity in different areas, mining conditions, and taxation practices at the state level.

Some readers may be concerned that little has been said about competition from nuclear energy or solar power. The contribution of solar energy to overall electricity generation is expected to be insignificant before 1990, and only slight before the year 2000. All current studies of future power needs and energy sources agree on this point. Nuclear power is a different matter. Currently, much of the planned nuclear capacity has been sidelined or delayed, and much of the power generation planned as nuclear may be converted to coal.[15] This is due to extremely rapid and large increases in nuclear power plant construction costs, increasing difficulty in obtaining construction permits, and the possibility that future nuclear capacity may require imported fuel.[16] The poor availability of nuclear plants compared to cool-fired units and their rising costs should also be noted. If anything, trends in nuclear power generation suggest an expanded steam coal market.

In summary, steam coal markets for the 208 area are likely to expand, both geographically and in absolute size. It is believed that the most likely level of production to be reached by Illinois Basin steam coal is that approximating the "Reference" scenario in the FEA's 1977 Draft Energy Outlook.[17] To reach the level of production implicit in such a forecast, 208 area steam coal mining would have to increase at about 4% per year between 1975 and 1985. It is not deemed likely that such a rate of expansion will be maintained after 1985, since conversion of utilities from other fuels to coal should have stabilized, energy conservation should have begun to have serious impact on electricity demand, and the nuclear industry may again be expanding its share of electricity production. For these reasons the projected expansion of 208 area steam coal production is set at 2% per year in the period 1985-1995. Some readers, mindful of recent market losses for Illinois coal as a result of the Clean Air Act of 1970, may find the prospect of

greatly expanded steam coal sales difficult to believe. Interested readers are referred to Table 10, listing capacity expansions planned by utilities currently purchasing 208 area steam coal. Much of the contracted demand in this table is related to announced new or expanded mines in the 208 area.

Market Prospects for Industrial and Coking Coals, and Synthetic Fuels

While it is believed likely that 208 area steam coal markets will grow rapidly until 1985, this optimism is not extended to the market for industrial coal. The 208 area produces over 1/3 of the Illinois Basin's industrial coal, but in recent years, production has fallen rapidly as increasingly stringent SO_2 emission standards have forced conversion to oil, gas, or low sulfur Appalachian coal.[18] The parts of the federal Energy Plan relating to reconversion of oil and gas using industries to coal is one of the least popular, and the record does not indicate that a vigorous federal program of industrial conversion to coal is being prepared or pursued. Undoubtedly, industrial demand for coal will increase, in the nation, the Illinois Basin, and the 208 area, but it is hard to conceive of existing or future industries burning 208 area coal at 22 to 25.0 million Btu/ton and .90-.95 lbs. sulfur/million Btu (barely meeting existing standards) when it may be seen as safer, if not as cheap, to convert to electricity. The industrial market is relatively small, as are most individual purchases, and absolute shortages such as those forecast for steam coal, are not likely to force mass purchases of 208 area coal. After 1985, a continuation of moderate growth is foreseen, so that 1971-1972 production levels are not expected to be exceeded until the early 1990's. In general, this projection of industrial consumption follows that suggested by Verl Johnston for the Illinois Basin industrial market.[19]

The Southern Illinos 208 area produces 100% of the Illinois Basin's rather small coking coal production. Most of this coal comes from unusually deep underground mines of low sulfur deposits in Franklin and Jefferson Counties, and is supplemented by one to two hundred thousand tons per year from the Sahara mines in Saline County.[20] Recently, the domestic steel industry has been closing plants and reducing production due to alleged dumping of foreign steel on the U.S. market. Modernization of basic steel plants in the United States would result in lower costs per ton, and such steps are increasingly likely.[21] While modernization will improve the economic health of the steel industry, it will result in more efficient use of coking fuels, with resulting lowered consumption. Further, new processes such as formcoking are liable to broaden the range of coal qualities acceptable to the industry, which may result in the choice of cheaper, higher sulfur fuels than the 208

Table 10
POTENTIAL NEW STEAM COAL MARKETS FOR 208 AREA MINES

State	County	Location	Utility	Plant	MW	Coal Demand (Million Tons) 1980	1985	Transport Mode
Ill.	Peoria	Bartonville	CILC	Edwards #4	500	-	1.3	Rail
Ill.	Fulton	Canton	CILC	Duck Creek #2	400	-	1.1	Rail
Ill.	Mason	Havana	IPC	Havana #6	450	1.2	1.2	Rail
Ill.	Sangamon	Springfield	SM	Dallman #3	176	.15	.57	Rail
Ill.	Jasper	Newton	CIPS	Newton #2	550	-	1.13	Rail
Ill.	Jasper	Newton	CIPS	Newton #3	550	-	1.13	Rail
Ind.	Jasper	Wheatfield	NIPSC	Shahferl #5	527	1.2	1.2	Rail
Mich.	Ottawa	Grand Haven	GHM	Island #3	80	-	.4	Rail
Mich.	Ottawa	Port Sheldon	CPC	Campbell #3	802	1.65	2.15	Rail
Mich.	Branch	Coldwater	CM	Campbell #7	20	-	.1	Rail
Wis.	Buffalo	Alma	DPC	Alma #6	350	1.3	1.3	Rail, Barge
Wis.	Marathon	Rothschild	WPSC	Weston #2	75	.2	.2	Rail
Wis.	Marathon	Rothschild	WPSC	Weston #3	300	-	.4	Rail
Wis.	Sheyboygan	Sheyboygan	WP&LC	Number 5	400	-	.8	Rail
Wis.	Kenosha	Pleasant Prairee	WEPC	Number 1	580	1.0	1.0	Rail
Wis.	Kenosha	Pleasant Prairee	WEPC	Number 2	580	-	1.0	Rail
Wis.	Jefferson	Koshkoning	WEPC	Number 1	400	-	1.0	Rail
Wis.	Jefferson	Koshkoning	WEPC	Number 2	400	-	1.0	Rail
Minn.	Sherburne	Becker	NSPC	Number 3	800	-	1.4	Rail, Barge
Minn.	Sherburne	Becker	NSPC	Number 4	800	-	1.4	Rail, Barge
Iowa	Muscatine	Muscatine	MM	Number 9	55	-	.15	Rail, Barge
Ala.	Washington	Leroy	AEC	Tombigbee	210	.6	.6	Rail, Barge
Ala.	Washington	Leroy	AEC	Tombigbee	210	.6	.6	Rail, Barge
Miss.	Lamar	Purvis	SMEPA	Morrow #1	180	.25	.64	Rail, Barge
Miss.	Lamar	Purvis	SMEPA	Morrow #2	180	.25	.64	Rail, Barge
Miss.	Jackson	Wade Point	MPC	Moss Point #2	500	.89	.89	Rail, Barge
Ill.	Williamson	Lake of Eqypt	SIPC	Number 4	173	.15	.33	Rail, Barge
Ill.	Williamson	Lake of Egypt	SIPC	Number 5	150	-	.48	Rail, Truck
				TOTALS:	10398	9.44	24.11	

Note: Southern Illinois 208 area mines will have to supply 60 to 75% of these new units in order to reach forecast production levels in 1985.

Source: Federal Power Commissions Status of Coal Supply Contracts to New Electric Generating Units 1976-1985 Federal Power Commission, January, 1977.

area reserves now employed. An additional factor is that low sulfur reserves suitable for present industrial and coking needs have been largely mined out except where they are thinner or deeper than the usual Illinois Basin steam coal mine reserves. While, in past years, the superior low sulfur reserves were concentrated in the 208 area of Illinois, the remaining reserves are as attractive outside the 208 area as inside. Thus the last two large, low sulfur, deep mines to be built are in Hamilton and Wabash Counties, well away from the traditional low sulfur coal production area. In the future, the 208 area is projected to lose its monopoly of coke production but the process will be gradual, and coke production is expected to maintain a slow rise throughout the forecast period of 20 years. In general, the coke forecast is for 2½% per year growth to 1985, and about 2% per year growth from 1986 to 1995.

A potential sector of 208 area coal demand explicitly considered by few forecasters is the demand for synthetic fuels from liquifaction and gasification of coal. Several projections of demand for such fuels have shown a rapidly expanding market for such products after 1985, as shown in Table 11. A recent survey found eight areas with high potential as coal gasification sites in the U.S. Parts of two of these areas are within the 208 area where a large gasification plant is currently under consideration[22] (See Figure 11). We have estimated the share of total synthetic fuel production from coal in the 208 area as 7½% of national demand, considering the area's massive coal reserves, adequate water supplies, and location in a large potential synthetic fuel market area. If the gasification plant currently planned for Perry County is built on schedule, coal consumption for this plant alone would reach .6 million tons by 1985 and about 10.0 million tons by 1995.[23] It is possible that another such plant will be considered in the lower Saline River Basin in Gallatin County or in eastern Williamson County, and that smaller plants may be constructed for on-site servicing of industrial parks and/or communities.[24]

Conclusion: 208 Area Coal Demand 1975 - 1995

Staff forecasts of total coal development for the 208 area are shown by demand sector in Table 12. In addition to many factors discussed above, others could have been introduced into the discussion of market potential, however, uncertainties would not have been substantially reduced. For example, one constraint upon surface mining is the costs imposed by varying state reclamation laws.[25] A great deal of discussing of the relative impact of different statutory provisions has taken place, but the costs of reclamation are influenced as much by intangibles (such as the vigor of reclamation law enforcement) as they are by the legal provisions themselves.[26] It has been mentioned above that the strongest competition for development of future surface mines in Southern

Figure 11

Areas of High Potential for Gasification Development

Source: Lindquist, A. E., Siting Potential for Coal Gasification Plants in the United States, Information Circular #8735, U. S. Dept. of Interior, U. S. Bureau of Mines, 1977.

Table 11
NATIONAL COAL DEMAND FOR SYNTHETIC FUELS,
AND 208 AREA PRODUCTION SHARE (MILLIONS OF TONS/YEAR)

	1985	1990	1995	2000
High Demand	26	64	158	390
Low Demand	17	72	103	225
208 Share (7½% of average.)	1.61	5.1	9.79	23.08

Sources: 1) Federal Energy Administration, 1977 National Energy Outlook, Draft, U.S.Dept. Interior, Washington D.C., Jan. 1977.

2) Dupree, W.G. and J.S. Corsentino, U.S.Energy Through The Year 2000 (revised). U.S.Bureau of Mines, Dept. Of Interior, Washington D.C., 1975.

Table 12
FORECAST COAL PRODUCTION BY DEMAND SECTOR,
1975-1995, S. ILL 208 AREA
(millions of tons/year)

Demand Sector	1972	1975	1976	1977	1980	1985	1990	1995
Cokeing Coal	3.8	4.3	4.0	3.4	3.8	5.0	5.8	6.3
Industrial Coal	5.5	4.0	3.7	3.4	4.2	4.7	5.6	6.8
Steam Coal	25.6	23.1	21.8	20.3	26.8	33.1	35.9	38.7
Synthetic Fuel	0.0	0.0	0.0	0.0	0.0	1.6	5.1	9.8
Total Demand	34.9	30.4	29.5	27.1	34.8	44.4	52.4	61.6
	------ Record ------			---------- Forecast ----------				

NOTE: Total demand reflects demand for recycled coal from mine wastes which is not tabulated in production statistics available from state agencies.

SOURCE: GERP&DC staff.

Illinois comes from western Kentucky strip mines, where state reclamation laws have not always been vigorously enforced.[27] The threat of imposition of a federal reclamation program under P.L. 95-87 may be sufficient to increase western Kentucky reclamation costs by $1.00 per ton, or about $.044 per million Btu. The effect such a change could have on relative market shares (see Table 9) is profound, but it cannot be assumed that the new federal agency (Office of Surface Mining) will move either rapidly or effectively to force compliance with the new reclamation standards of P.L. 95-87.

In short, the forecast demand levels must be viewed as subject to revision when federal regulatory policies have stabilized, and/or coal producers' response to regulatory change has been better measured. In reviewing the forecasts provided here, it is appropriate to suggest that the supply considerations discussed in the following chapter are of equal importance in influencing actual production.

FOOTNOTES FOR CHAPTER 2

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[5]I.B.M. Incorporated, Federal System Division, Illinois Coal Study, 1970.

[6]Malhotra, Ramesh. Market Potential for Coals of the Illinois Basin, Illinois State Geological Survey, Illinois Minerals Note 67 (Urbana, Illinois, Illinois State Geological Survey, August 1977).

[7]Mutschler, P. H., R. J. Evans, and G. M. Larwood. Comparative Transportation Costs of Supplying Low-Sulfur Fuels to Midwestern and Eastern Domestic Energy Markets, U.S. Bureau of Mines Information Circular 8614 (Washington, D.C., U.S. Bureau of Mines, 1973).

[8]U.S. Congress, Public Law 95-87 The Surface Mining Control and Reclamation Act of 1977, 91 Stat. 445, U.S.G.P.O., 1977.

[9]Office of Surface Mining Reclamation and Erforcement, U.S. Dept. of the Interior, "Surface Mining Reclamation and Erforcement Provisions," Federal Register, Vol. 42 #173, September 7, 1977, pp. 44920-44957.

[10]Keystone Coal Industry Manual, 1977, (McGraw Hill, Mining Information Service, New York, New York, 1977).

[11]Ibid.

[12]Editors of Coal Outlook, F.E.R.C. Form 423 reprints, Jan.-Aug. 1977.

[13]Malhotra, Ramesh. op. cit.

[14]Executive Office of the President, Energy Policy and Planning, op. cit.

[15]Malhotra, Ramesh. op. cit.

[16]Anderson, E. U. "Nuclear Energy; A Key Role Despite Problems." Chemical and Engineering News, V. 55, #10, p. 9.

[17]Federal Energy Administration. 1977 National Energy Outlook, Draft (Washington, D.C., F.E.A., Jan. 15, 1977).

[18]Malhotra, Ramesh. op. cit.

[19]Johnston, Verl. "Coal Demand Through 1985," paper presented at the NCA/BCR convention, October 19-21, 1977, Louisville, Kentucky.

[20]Mutschler, Paul H. Impact of Changing Technology on the Demand for Metallurgical Coal and Coke Produced in the United States to 1985, Information Circular 8677 (Washington, D.C., U.S. Bureau of Mines, 1975).

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[26]Fritsch, Albert, J., Mark L. Morgan, Glenn G. Yanik, Thomas J. Conry, and David E. Taylor. The Enforcement of Strip Mining Laws in Three Appalachian States: Kentucky, West Virginia, and Pennsylvania, Center for Science in the Public Interest Energy Series VIII (Washington, D.C., Center for Science in the Public Interest, January, 1976).

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Chapter 3

FACTORS INFLUENCING COAL SUPPLY IN THE 208 AREA

Economically Significant Coal Reserves for the Forecast Period

The object of this chapter is to locate likely sites for coal and coal industry development. In order to do this, it is necessary to define surface and underground reserves likely to be exploited between 1975 and 1995. As was shown in Chapter 1, the 208 area coal resources are vast. The forecast developed for this report implies total production of some 441.2 million tons by surface mining and 489.1 million tons by underground methods, with total depletion (including reserves rendered unmineable by mining) of 1,590.2 million tons, or about 5% of the total resource and 8.4% of the demonstrated reserve base. The question, then, is which 5% of the total resource is likely to be mined before 1995?

The answer promoted herein stems from analysis of the costs of coal extraction. Mining costs (including producers' profit) were estimated by subtracting estimated transportation costs from delivered prices in F.E.R.C. form 423 reports, and this information was compared with mine cost information in several sources.[1,2,3,4,5,6] Criteria for least expensively mineable areas were created as follows.

A.) Surface Mining Area Criterias:

1.) Excluded coal: coal under developed areas, roads, railroads, and public reserves, coal less than 18" thick.

2.) Included coal:[7] Coal 18-29" thick and less than 50' deep
30-47" thick and less than 75' deep
48-71" thick and less than 100' deep
72-101" thick and less than 125' deep
102" up to 150' deep.

Seams less than 30' apart are considered as one seam.

B.) Underground Mining Area Criteria:

1.) Excluded coal: coal under developed areas, roads, railroads, public reserves, heavily drilled areas, and coal included in A.) above.

2.) Included coal:

a.) All low sulfur (2% sulfur on an as received basis) coal over 66" thick

b.) Other coal less than 1,000' deep, but over 66" thick, when in the #6 seam

c.) Other coal over 42" thick and less than 400' deep, or in the #5 seam overlaid by thinner #6 coal

d.) #6 coal underlain by low sulfur #5 coal was excluded.

Coal tonnages by township were tabulated by nomograph from Illinois State Geological Survey maps, assuming 1770 tons per acre foot[8,9,10,11,12,13] and were combined with information in the Illinois Coal Study.[14] Coal in deep mineable areas was tabulated by low and high sulfur categories (Table 13, Figure 12), coal in surface mining areas was tabulated by county, and by contiguous block. Surface areas were further categorized as "assigned" if needed to support 20 years of production for existing or announced capacity now operating adjacent to the reserve block. Coal in blocks too small to support 500,000 tons per year of production for a 20 year mine life were categorized as "spot reserves." Remaining surface mineable coal blocks were catagorized as "available" to support projected new mine capacity as yet unannounced. Relationships between production capacity and reserve block size were as follows: 85% mining efficiency was assumed; and 20% cleaning losses were deducted. Thus a shipped production of 2.0 million tons per year would require:

$$(1/.85)(1/.80)(2.0) = 2.94 \text{ million tons of coal}$$

and a 2.0 million ton per year mine's mininum required reserve block would be:

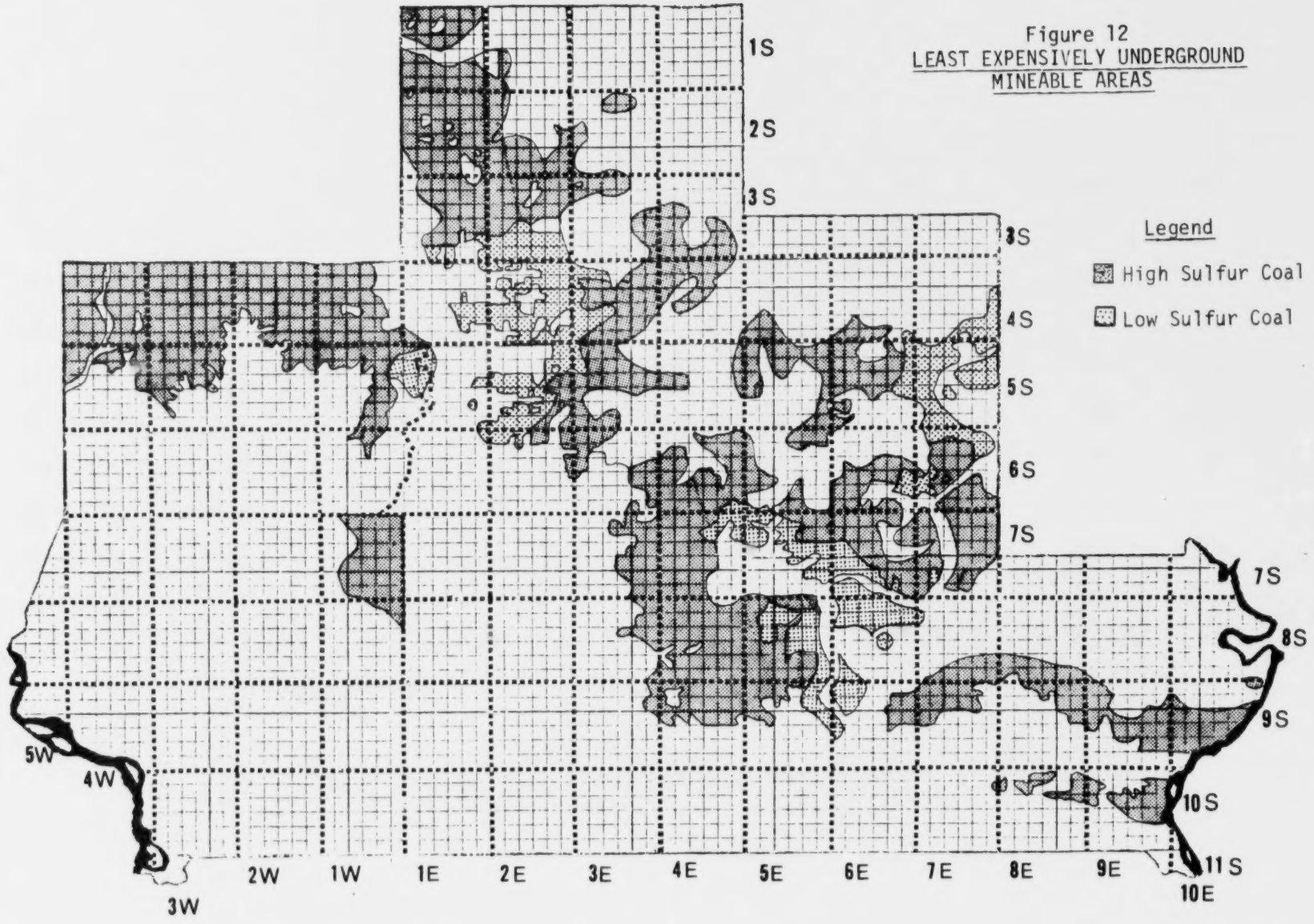
$$(1/.85)(1/.8)(2.0)(25) = 73.50 \text{ million tons of coal}^{15,16}$$

The "available reserves" were converted to annual production capacity by a factor of

$$(.85)(.80)(.04) = .0272$$

which would yield a total annual capacity of 17.? million tons per year

Figure 12
LEAST EXPENSIVELY UNDERGROUND
MINEABLE AREAS



Source: Various Illinois State Geological Survey Publications

Table 13
COAL IN AREAS LEAST EXPENSIVELY UNDERGROUND MINED
(Millions of Tons)

	Assigned Reserves		Available Reserves		Total		
Place/Type	<2.% Sulfur	>2.% Sulfur	<2.% Sulfur	>2.% Sulfur	<2.% Sulfur	>2.% Sulfur	All
Perry	0	0	63	1427	63	1427	1490
Jefferson	98	0	538	1378	636	1378	2014
Franklin	185	160	140	669	325	829	1154
Jackson	0	0	0	153	0	153	153
Williamson	0	97	0	359	0	456	456
Hamilton	100	0	257	972	357	972	1329
Gallatin	0	45	0	323	0	368	368
Saline	28	0	395	478	423	478	901
Total	411	302	1393	5759	1804	6061	7865

Source: GERP&DC Staff.

(in mines over 500,000 tons per year) which could be installed in the available reserves. The location of this coal is shown in Table 14 and Figure 13.

Available deep-mineable areas contain 7,152 million tons of coal. A mining recovery factor of .55 was assumed, and a total recovery after cleaning of .45 for room and pillar mines. For longwall mines a mining recovery of .9 was used and a total recovery of .7 was used (longwall units are assumed to be responsible for 20% of underground coal mined after 1985). Seven thousand one hundred fifty two million tons of deep-mineable coal could support about 135 million tons per year of new mine capacity for 25 years. Clearly, future surface production may be constrained by supply, but underground production will not be.

Before proceeding to nominate the most likely sites for future mines, it is appropriate to consider what the projected demand for 208 area coal (developed in Chapter 2) implies for the various producing sectors in the 208 area.

Coal Supply by Production Sector

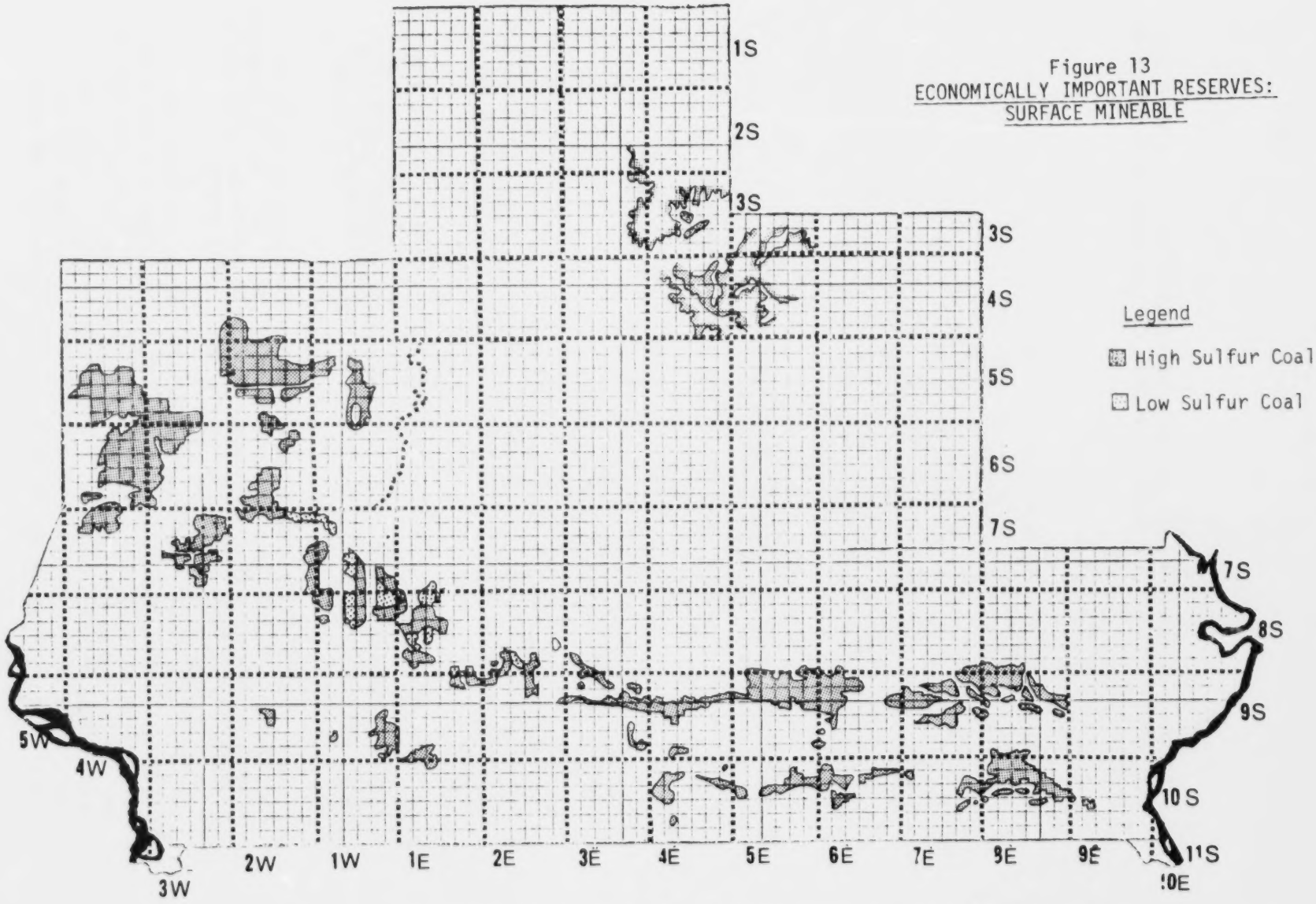
208 area coal is mined by both large and small mines and by both surface and underground methods. As an aid in understanding the implications of the forecast, annual production has been broken into five producing sectors:

1.) Large Surface Mines - those with a capacity of 500,000 tons per year, or more. Eleven such mines produce some 92% of the region's surface-mined coal. This is utility-steam coal, although some is low sulfur and some is blended with low sulfur coal for industrial customers.

2.) "Spot" Mines - small surface producers averaging 10,000 to 250,000 tons per year of steam coal. Production of this sector responds readily to price and cost variations. One small underground producer of domestic stoker coal is arbitrarily included in this group.

3.) "Gob Mines" - arbitrarily included as surface mines, this category includes production from small scale recycling of older mine refuse from gob piles and slurry ponds. Production is not tabulated by any public agency, but is estimated to have been 300,000 tons in 1977. Most of this material can be sold as low sulfur steam or industrial coal. Reserves are estimated to be about 20% of estimated gob totals (Table 15). Some gob shown in Table 5 is not low sulfur, but this

Figure 13
ECONOMICALLY IMPORTANT RESERVES:
SURFACE MINEABLE



Source: Various Illinois State Geological Survey Publications, materials

Table 14
COAL IN AREAS
LEAST EXPENSIVELY SURFACE MINED
(Millions of Tons)

	"Spot" Reserves	Assigned Reserves	Available Reserves	Total
Franklin	0.0	2.9	0.0	2.9
Gallatin	7.9	33.1	94.7	135.7
Hamilton	0.0	2.0	5.1	7.1
Hardin	1.1	0.0	0.0	1.1
Jackson	48.6	104.5	110.2	263.2
Jefferson	0.0	2.9	21.8	24.7
Perry	10.1	418.6	220.1	648.8
Pope	3.1	0.0	0.0	3.1
Saline	33.8	85.4	119.3	238.5
Williamson	116.0	67.0	60.2	243.2
Total	220.6	714.4	631.3	1568.3

Note: Totals may not add due to rounding.

Source: GERP&DC Staff.

material is balanced by an unknown tonnage of recyclable slurry. Six million tons of salvageable material were estimated to remain as of January 1, 1978.

Table 15
RECYCLABLE GOB RESERVES AS OF JANUARY 1, 1971

County	Deep Mine Gob Acreage	Deep Mine Gob, Yds^3	Surface Mine Yds^3	Surface Mine Gob Acreage	Total Yds^3	Tonnage at .3707 tons/Yd^3
Franklin	627.2	2,408,873	0	0	2,408,873	892,969.2
Gallatin	17.0	11,054	0	0	11,054	4,097.7
Jackson	139.8	1,127,542	241,962	30	1,369,504	507,675.1
Perry	157.7	3,255,181	3,019,659	170	6,27[illegible]940	2,326,583.1
Saline	359.0	2,047,150	3,090,683	542	5,137,833	1,904,594.6
Williamson	155.2	1,684,860	3,224,249	297	4,909,109	1,819,806.7
All	1,429.9	10,534,660	9,576,553	1,039	20,111,213	7,455,226.4

Sources: From Haynes, Ronnie J. and Klimstra, W. D. Illinois Lands Surface Mined for Coal, Cooperative Wildlife Laboratory, S.I.U. Carbondale, June 1975.;

Klimstra, W. D. unpublished data on underground mine sites with estimates of gob cubic yardage by site. This data was supplied to the 208 project in 1977.

4.) High Sulfur Deep Mines - these are underground mines having an annual capacity of approximately 1-2 million tons per year producing primarily steam coal, although some of the older mines may have produced industrial coal before the exhaustion of their low sulfur reserves. Currently, six such mines produce about six million tons per year. Several new mines in this category are under construction or being planned. Recent trends in Illinois have emphasized mines of 2-3 million tons annual capacity in seams at least 6 feet thick and less than 250 feet deep.[17] Smaller mines will be constructed in thinner coal (½ to 1 million tons per year).

5.) Low Sulfur Deep Mines - these mines produce primarily coking or industrial coal, with some less rigorously cleaned coal being sold to

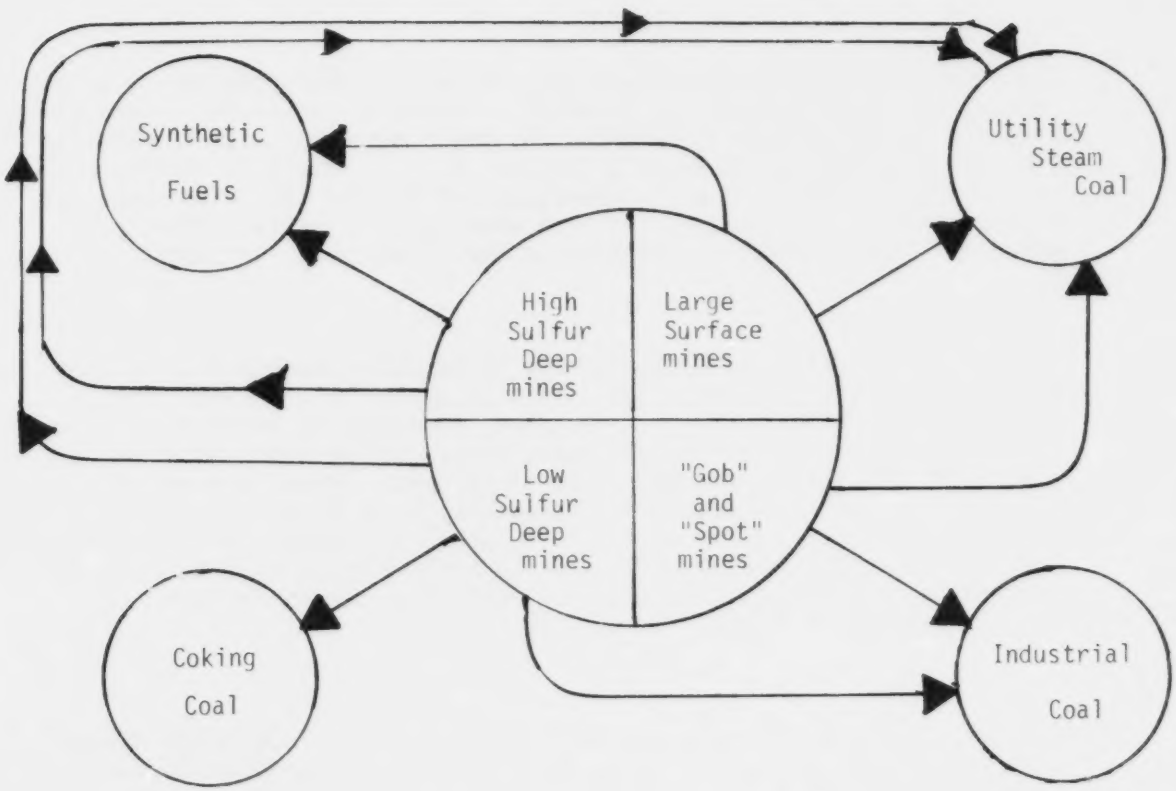
utilities. It should be noted that the "coke button," or free swelling index, not sulfur or ash, is the primary determinant of a good coking coal. Of seven such mines in Illinois, six are in the 208 area, and one new one is under construction. Future mines in this category will be of two types - mines of about 3.0 million tons per year capacity exploiting 5' to 8' thick seams at depths of 600' to 1000', and mines of about 3/4 million tons annual capacity exploiting seams 4' to 6' thick at depths of 400' or less. These smaller mines may have a shorter operating life (about 10-15 years) than the larger mines.[18,19,20,21]

The general relationships between the forecast of the demand and supply sectors are summarized by the schematic drawing in Figure 14. Those interested in the product differences for these mines may wish to refer to the averages computed in Table 6 (Chapter 2). It should be understood that these averages are merely averages, and further that wide ranges of product characteristics occur in each mine type. Finally, almost all mines sell small quantities of coal to their employees for domestic use.

Before presenting the breakdown of the forecast by these supply sectors, a brief discussion of production losses is appropriate. Mines have life-cycles of productivity. A new mine, announced as having a design capacity of 2.0 million tons per year, should not be expected to produce a uniform 2.0 million tons each year it is open. Annual production figures for a given mine tend to increase up to or slightly beyond announced capacity figures within a few years of capacity installation. Thereafter, production tends to steadily decline until mine capacity is expanded or the mine closes. Typical production curves for existing cases are shown in Figures 15a and 15b.

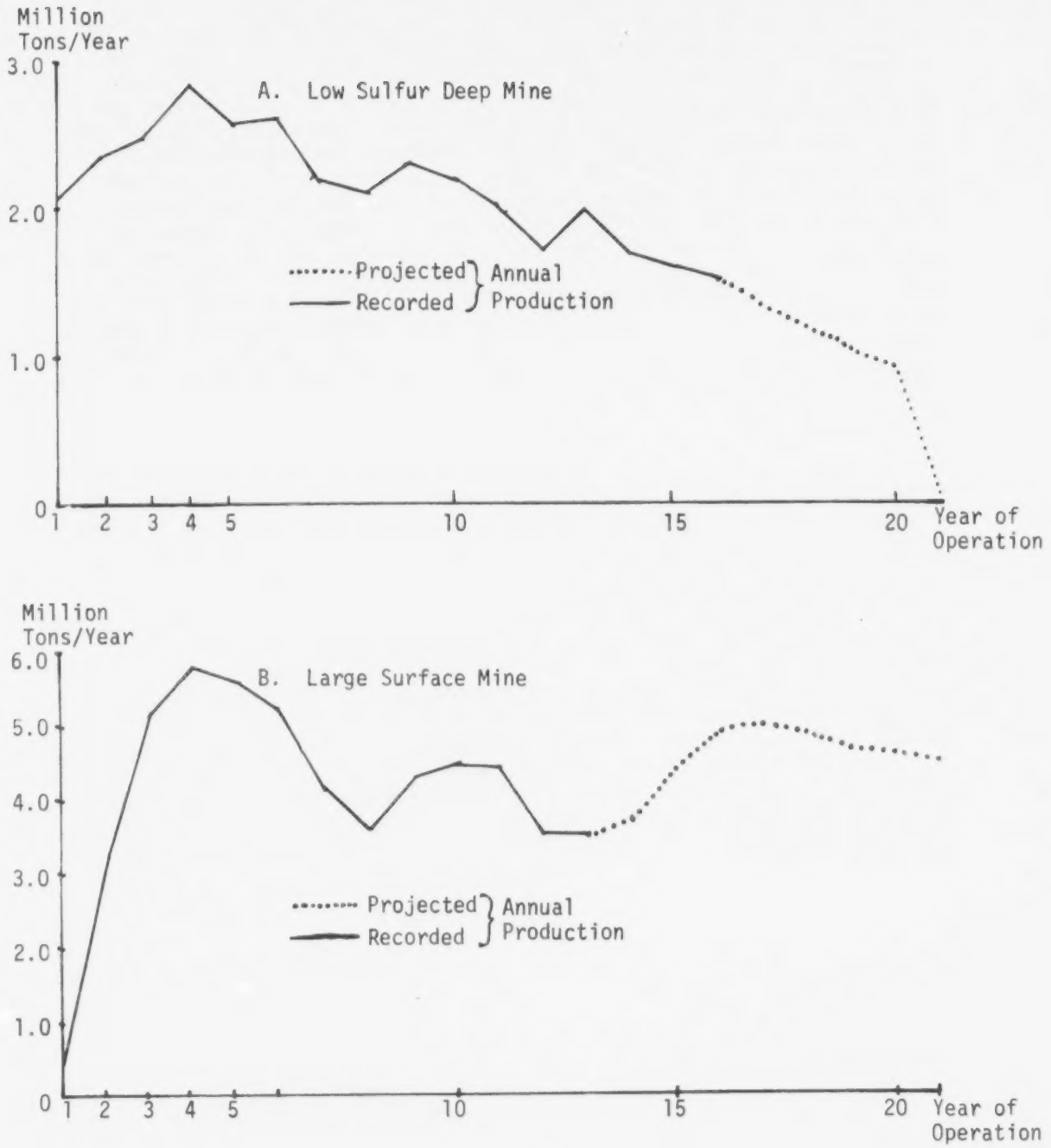
Reasons for the declining production as mines age include longer travel time to underground working faces, mining deeper and/or thinner coal in surface mines, and increased maintenance time due to aging equipment.[22] In recent years, mine productivity has been reduced due to the dilution of the trained manpower pool by rapid expansion of the industry, union work rule changes allowing more inter-job mobility, and the regulations of the 1969 Coal Mine Health and Safety Act.[23] One 208 area mine closed due to unstable roof strata, and the general pattern of production losses suggests that area low-sulfur deep mines have lost production due to softening of the market for industrial and coking coal.[24] Undoubtedly, wildcat strikes have cost several million tons of production annually in the last two or three years. National contract strikes do not usually cause annual production losses unless their length exceeds expectations. These strikes occur in December and January, and the mines produce more in the other seasons of the year, while customers stockpile coal in anticipation of the strike.

Figure 14
RELATIONSHIPS OF COAL
SUPPLY AND DEMAND SECTORS



Source: Greater Egypt Regional Planning and Development Commission Staff.

Figure 15
TYPICAL PRODUCTION HISTORIES
FOR LARGE 208 AREA MINES



Source: Illinois State Department of Mines and Minerals, Annual Coal Report, 1964-1976.

Given declines in production, the production from a group of new mines would normally peak and then slowly dwindle. Thus, new mines must be added from time to time to maintain a static level of production. The rate at which overall production for a region declines is termed "retirement." The present period is generally recognized as one of unusually high rates of retirement. The FEA, in 1974, suggested calculating regional retirement at 5% of 1972 production until 1980, and at 3% of annual production thereafter.[25] Malhotra modified this to 5% of annual production to 1980 and 3% per year thereafter.[26] For the 208 area, the 1973-76 production record for all surface and underground mines producing over 300,000 tons per year was examined. Production losses averaged 9% per year for low sulfur deep mines, 5% per year for high sulfur deep mines, and 6% for large surface mines. These rates were employed in the forecast until 1980, when a 3% retirement rate was substituted. If the present pattern of high productivity losses should continue after 1980, little growth can be expected, for all the announced new mines would lose capacity rapidly and production would soon fall below present levels.

When retirement and new capacity additions are considered, the 208 area production forecast by supply sectors is as shown in Table 16. The new capacity required to meet forecast production levels is shown in Table 17. Readers will note that while large surface mines are forecast to expand production steadily throughout the 1977-1995 period, utilizing most of the available reserves, that the relative percentage of all coal produced which comes from such mines decreases from over 50% to about 45% by 1995. At present, the costs of surface mining are increasing more rapidly than the costs of underground mines. The trend is partly due to increased recovery costs and partly due to regulatory and reclamation law requirements. Despite such changes, the 208 area is receiving a disproportionately large share of the new surface mine capacity being developed in the Illinois Basin (See Table 18). Thus surface mining may continue to increase in total tonnage produced for almost all of the forecast period, but its share of production is likely to decrease after the early 1980's.

Table 16
PROJECTED COAL PRODUCTION BY SUPPLY SECTOR
(millions of tons per year)

Sector of Production	1971	1975	1976	1977	1980	1985	1990	1995
Large Surface Mines	11.1	15.1	14.9	13.6	17.1	19.8	23.6	22.9
High Sulfur Deep	9.1	6.4	6.0	5.6	10.6	13.9	16.2	22.5
Low Sulfur Deep	9.4	8.0	7.3	5.8	5.6	9.0	10.9	13.1
"Gob" and "Spot" Mines	1.7	0.9	1.3	2.1	1.5	1.7	1.7	3.1
Total Production	31.3	30.4	29.5	27.1	34.8	44.4	52.4	61.6
		Record			Forecast			

Note: Totals may not add due to rounding.

Source: GERP&DC staff.

Table 17
NEW MINE CAPACITY REQUIRED TO MEET FORECAST PRODUCTION LEVELS
(millions of tons/year)

Supply Sector	1975-1980	1981-1985	1986-1995	Total 1976-1995
Low Sulfur Deep Mines	1.4 (1.4)	4.5 (1.1)	7.4 (0.0)	13.3 (2.5)
High Sulfur Deep Mines	6.0 (6.0)	5.2 (4.2)	9.6 (.4)	20.8 (10.6)
Large Surface Mines	7.0 (6.6)	6.6 (1.0)	14.7 (0.0)	28.3 (7.6)
Gob and Spot	n/a	n/a	n/a	n/a
TOTAL	14.4	16.3	31.7	62.4 (20.7)

Note: Announced new capacity is shown in parentheses, but is introduced on the following basis: 1/3 on year of capacity installation and 1/3 in each of the following two years. This provides a realistic way of incorporating the lag between capacity installation and full production from that capacity into estimates of annual production. All new capacity is entered into retirement calculations in the year it enters production.

Source: GERP&DC staff (Formally announced portion of expected new capacity taken from Neilsen, G. F., Keystone Coal Industry Manual, 1977.)

Table 18
COMPARISON OF SURFACE PRODUCTION SHARE
AND NEW SURFACE CAPACITY SHARE
FOR ILLINOIS BASIN SUB-REGIONS
(thousands of tons)

	208 Area	N. IL	W. KY	Ind.	Total IL Basin
1975 Surface Prodn.	15,594	13,429	31,334	23,584	83,941
% of Total	18.6%	16.0%	37.3%	28.1%	100%
New Surface to 1985	7,900	2,000	7,600	2,300	19,800
% of Total	39.9%	10.1%	38.4%	11.6%	100%

Sources: 1.) U.S.B.M. Minerals Yearbook, 1975
2.) Neilsen, George F. "Coal Mine Development and Expansion Survey," 1977 Keystone Coal Industry Manual

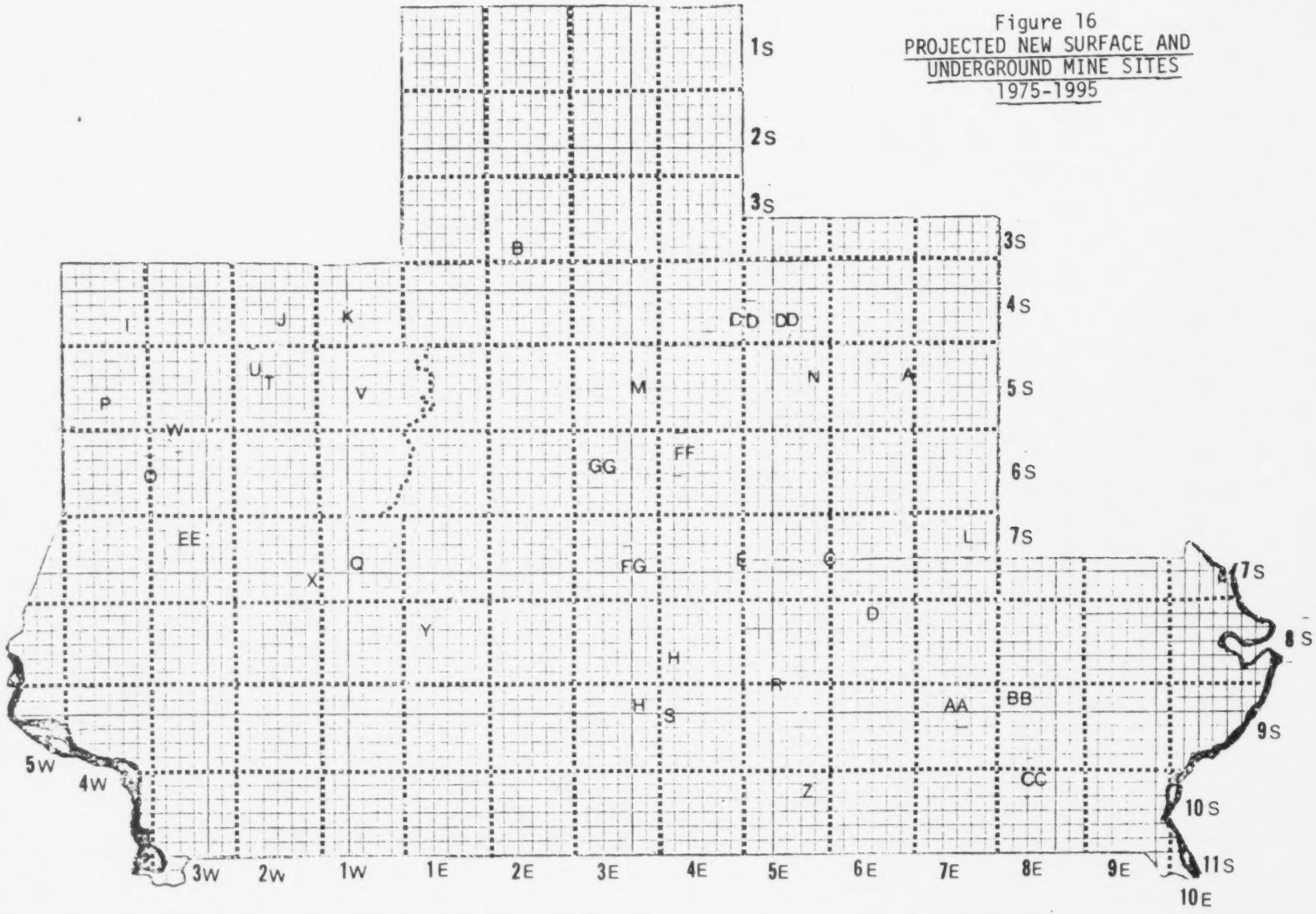
Potential Locations of New Mines

Based on staff estimates of mining costs and knowledge of mineral rights ownership, likely future mine sites have been selected. For surface mines this is relatively easy, as all available reserves are expected to be used to support the projected mining levels. For deep mines, relative mine costs have been estimated by seam thickness, depth, annual capacity, and estimated dates of first production are supplied. In evaluating the new mine list, it should be borne in mind that ownership of midwestern coal reserves is concentrated and new mines may not occur strictly according to increasing costs, but more according to the regional production requirements of an individual producer.

The mine sites chosen are listed below by name, letter (which identifies them on Figure 16), production capacity, and estimated first production date (if announced):

				Million tons/yr
A.	"Inland Steel #2"	Low Sulfur Deep	1978	2.5
B.	"Marcoe-Nason"	Low Sulfur Deep	n/a	3.0
C.	"Galatia"	Low Sulfur Deep	n/a	3.0
D.	"Raleigh"	Low Sulfur Deep	n/a	2.5

Figure 16
PROJECTED NEW SURFACE AND
UNDERGROUND MINE SITES
1975-1995



NOTE: This is a schematic rather than true scale map. Marginal numbers identify township and range. Letters indicating mines are identified in the text.

SOURCE: GERP&DC Staff.

				Million tons/yr
E.	"Tri County"	Low Sulfur Deep	n/a	2.5
F.	Old Ben #25	High Sulfur Deep	1977-1978	2.0
G.	Old Ben #27	High Sulfur Deep	1980	2.0
H.	Pittsburg	High Sulfur Deep	1978-1979	2.0
I.	Winkle	High Sulfur Deep	1982	2.1
J.	Tamaroa	High Sulfur Deep	n/a	2.0
K.	Little Beaucoup	High Sulfur Deep	n/a	2.0
L.	Broughton	High Sulfur Deep	n/a	2.0
M.	Ewing	High Sulfur Deep	n/a	2.0
N.	McLeansboro	High Sulfur Deep	n/a	2.0
O.	Captain "Denmark"	Large Surface	1977	2.0
P.	Jamestown "Rte 150"	Large Surface	1978	1.0
Q.	De Soto "West field"	Large Surface	1978	1.0
R.	Delta "No. America"	Large Surface	1978	1.6
S.	Delta "Crab Orchard"	Large Surface	1981	1.0
T.	Pinckneyville "Deep #3"	Large Surface	1979	1.5
U.	Pinckneyville "North"	Large Surface	n/a	2.0
V.	Pinckneyville "Sunfield"	Large Surface	n/a	1.0
W.	Captain "Horse Creek"	Large Surface	n/a	1.5
X.	B. S. #1 (Remining)	Large Surface	n/a	2.1
Y.	Blairsville	Large Surface	n/a	1.7
Z.	Carrier Mills	Large Surface	n/a	.5
AA.	Cottage Grove	Large Surface	n/a	1.0
BB.	Equality	Large Surface	n/a	1.5
CC.	Eagle	Large Surface	n/a	1.8
DD.	Dahlgren	Large Surface	n/a	.8
EE.	Sato	Large Surface	n/a	.9
FF.	Brushy-Bankston	Large Surface	n/a	.9

While the above seem the most likely sites, several others deserve mention. If the formcoking process provides an economic substitute for high grade metallurgical coal, U.S. Steel may develop one of its sites east of Benton to supply formcoke raw material. It is also possible the Freeman Orient #5 mine will reopen as a longwall mine.

GG. Middle Fork	High Sulfur Deep	2.0
HH. Orient #5	High Sulfur Deep	1.5

Potential Locations for Mine Related Facilities

While this chapter has dealt primarily with coal supply, a further purpose is to locate prospective sites for energy related activities, including coal fired steam-electric power plants and coal liquifaction-

gasification plants. Until the implications of the Clean Air Act have clarified, and final determination of Air Quality Maintenance Areas class I, class II and class III areas in southern Illinois has occurred, it is impossible to determine the feasibility of large, mine-head power plants in the 208 area.

Assuming that such plants remain possible, it is appropriate to consider sites which have the large sources of inexpensive coal and cooling water which such projects require. Southern Illinois groundwater supplies are inadequate for domestic and industrial supply, except in the alluvial valleys of the Mississippi and Ohio Rivers. Natural reservoir sites are and have been at a premium, and many remaining marginal reservoir sites may be required for community water supplies. The 208 area's two rivers, the Big Muddy and Saline, have marginal supplies for power plant cooling, and totally inadequate supplies for large scale consumptive use by coal conversion plants, although low flow problems could be alleviated by reservoir construction, if necessary. Good to excellent supplies of water are available from the area's boundary rivers, the Wabash, Ohio, and Mississippi.

It has been assumed that water demands for large power plants and conversion plants are as shown below:

A.) An 800 mw coal fired steam-electric power plant at 80% load factor should require 15 acre feet/year/mw or about 33 acre feet/day or 11 million gallons a day for once through cooling.[27]

B.) A 600,000 ton/year coal conversion plant such as the Illinois Coal Gasification Group (ICGG) proposed demonstration plant is projected to require 2.0 million gallons a day.[28]

C.) A 10 million ton/year coal conversion plant such as the proposed Illinois Coal Gasification Group commercial plant is projected to require 26 million gallons per day.[29]

Power plant construction of the above scale is not forecast for the 208 area, though in all, some 1500 mw of new capacity might be installed (2/3 of which may serve other areas). Such use is only partially consumptive. Thus only large scale coal conversion makes regionally significant water demands.

In general, it is less expensive to move large supplies of water over moderate distances than it is to move large tonnages of coal (especially if a pipeline right-of-way can be obtained at reasonable cost).

Therefore, superior power plant and coal conversion sites are to be found on major coal reserves (especially surface mineable coal) which are within 20-30 miles of major rivers (especially if pipeline rights-of-way already exist). These considerations prompt focus on several sites: Willisville - Pinckneyville in Perry County; DeSoto - Colp in Jackson and Williamson Counties; and Cottage - Grove - Shawneetown in Saline and Gallatin Counties. Each of these sites has adequate coal supplies to support both gasification and large-scale power plant development. Major surface mineable coal deposits exist in these areas, which can be supplemented by coal underground mined at shallow depths. The Willisville - Pinckneyville site has already been nominated for a coal conversion facility which, if built on schedule, would consume 10 million tons of coal per year by the mid 1990's.[30] Water (25 mgd) will be provided by a pipeline to the Mississippi River at Rockwood in Randolph County built on a right-of-way owned by area coal producers.[31] An additional right-of-way exists through Jackson County to the Mississippi near the Jackson - Randolph County border.[32] The area might provide an acceptable site for a major power plant, similar to the Illinois Power Co. plant at Baldwin in Randolph County. Four reservoir sites exist north of Pinckneyville.[33] Since three major coal producers are active in the Cutler - Willisville area, such a plant need not be tied to a particular coal supplier.

Further southeast, the DeSoto - Colp area contains major surface mineable coal supplies, some of which is low in sulfur (less than 1.5% sulfur; and approximately 23 million Btu/ton). This area is divided by the main stem of the Big Muddy River, which could supply a reservoir for a power plant through enlargement of an existing lake. The coal reserves in this area are also owned by several producers and holding companies.[34]

The third area straddles the Saline River, and is less than twenty miles from the Ohio River. Substantial coal reserves are available from both the Eagle Valley and Cottage Grove - Equality fields, both dominantly controlled by the same producer. This area forms part of one of the eight regions chosen by the Bureau of Mines as suitable for synthetic fuel production. The surface mineable coal reserves of this area are backed up by substantial underground mineable reserves. A coal conveyor right-of-way exists from Bowlesville, near the Saline River to the Ohio River at Shawneetown. A reservoir site in northern Gallatin County could provide 78 million gallons a day from the North Fork of the Saline River.[35]

Two other power plant sites are worthy of mention: 1) Grand Tower on the Mississippi in Jackson County; and 2) Lake of Egypt in Williamson

County. Grand Tower is the site of an existing intermediate sized Central Illinois Public Service coal fired plant (.5 million tons per year), for which no expansion has been announced. Recently, plans to develop the community as a coal loading facility were initiated by obtaining a Port Authority for the community. Proximity of this site to the existing right-of-way from the Cutler area (Q.V. above), and the prospect of major new markets for Illinois Basin coal in the southern Mississippi River Basin suggest the possibility of development in this area after 1980.

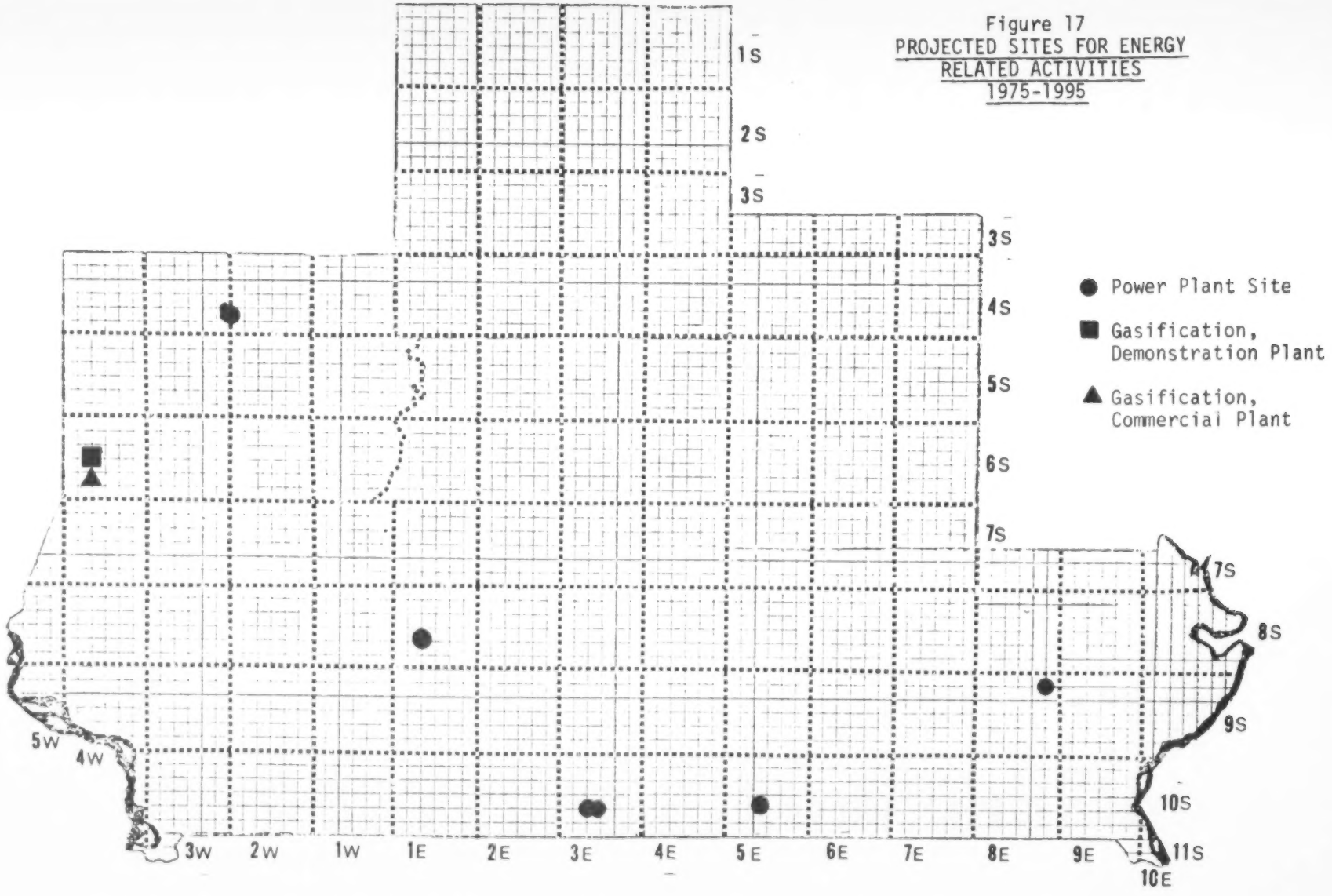
The other site of interest is the Southern Illinois Power Co-op's coal fired electricity generation complex utilizing a company built lake (Lake of Egypt) in south central Williamson County. Three existing units consume about 340,000 tons of coal, including recycled gob-coal and coal slurry per year; while an expansion unit of 160,000 tons per year capacity will come on line in 1978 and a fifth unit of similar size is planned for 1983.[36] This facility reportedly consumes about 150,000 tons of recycled gob and coal slurry per year, and projected units are expected to be about 40% dependent on this type of fuel.[37]

Finally, a potential power plant site exists in the watershed of the South Fork of the Saline River, where three reservior sites are available averaging 14.6 million gallons/day in yield.[38] A power plant on the South Fork of the Saline River could find a nearby coal supply from surface mining in the Davis - Dekovan seam, presently the site of a large scale surface mine in southern Saline County (Twp. 10S 5E). The suggested location of these sites is shown in Figure 17.

In conclusion, this chapter has projected what available information suggests is the most plausible scenario for future development of the 208 area's coal resources for the 1977-1995 period. Before proceeding to consider the potential impacts of this development on water quality, it is appropriate to reiterate several warnings concerning the use of the information provided, and to suggest several methods of improving the accuracy of the data.

First, all projections are data dependent. This one has been made in a time of uncertainties for coal producers and consumers: increased demand, increased production and use costs, declining mine productivity and a dynamic regulatory climate. Announced plans may change on short notice.

Figure 17
PROJECTED SITES FOR ENERGY
RELATED ACTIVITIES
1975-1995



Source: Greater Egypt Regional Planning and Development Commission Staff.

The data used herein are those in state and federal agency publications plus personal observation and hints from some kind-hearted coal and utility representatives. Such persons, regardless of their personal feelings, are unable to divulge industry plans or resource data considered confidential. The Illinois State Geological Survey is expected to publish a document re-defining the recoverable reserve base on Illinois' surface mineable coal in 1978 or 1979. Such information could improve the resource data used in this report. Knowledge of patterns of mineral rights ownership aids in predicting mine development. The Southern Illinois 208 project was not funded for the exhaustive research of county records necessary to compile detailed mineral rights ownership data. Available information was not sufficiently detailed to provide more than very general assistance. Leasing of mineral rights can preceed mining by twenty years or more. No useful data were found on floor and roof conditions, and other geo-engineering aspects of mine construction which are known to strongly affect deep-mining costs. Should any of the above information become available in quantity from a reliable source, it would be useful to re-perform the affected portions of the analyses on which this chapter's conclusions are based. Future researchers would be well advised to rely on persistence and scepticism.

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Chapter 4

WATER QUALITY RELATED IMPACTS OF 208 AREA ENERGY DEVELOPMENT

The primary purpose of this chapter is to review the expected energy related developments outlined in Chapter 3 from the standpoint of their potential impacts on water quality. The following subject areas are emphasized: 1) the potential impact of surface mining in affecting land use change; 2) the potential impact on water-dependent community services due to rapid population change as a result of new mines, power generation, and coal conversion facilities; and 3) the potential impact on water quality due to disposal of wastes from future mines and related industries.

Land Use Impacts of Energy Related Activities

It is estimated that about 31 square miles will be affected by surface mining by 1980, an additional 50 square miles between 1980 and 1985, and about 80 square miles more between 1985 and 1995. This is more than twice as much as would be affected by the extrapolation of present rates for the same period (See Tables 19 and 20). It should be noted that the acreage affected is not directly related to the gross tonnage produced. In general, thicker and shallower deposits have been mined first. This implies that with the passage of time and the mining of thinner deposits, greater acreages must be affected to produce identical tonnages. Further, as the larger contiguous blocks of reserves are exhausted, producers must develop more ingenious mining plans to adjust to waterways and public rights-of-way, and as surface mines grow older the working pit is frequently at greater distance from the preparation and loading facilities, thus requiring greater road acreages. Deeper or more difficult overburden conditions require more elaborate equipment with more land given over to maintenance and repair facilities.

For the purposes of the report, the breakdown of affected land use is shown in Table 20. The inclusion of acreages of "urban" and "public land" deserves a word of explanation. It is not intended that surface mining displace public park or city acreages. Many smaller 208 area communities contain within their city limits acreages of agricultural land not likely to be required for urban development in the foreseeable

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Table 19
SURFACE MINE AFFECTED LAND IN THE 208 AREA

Place	Pre-Law (Before 1962)	1962-75	1975-76*	Total	% of County Acreage
Gallatin	208	1,654.71	122.6	1,985.31	.94
Jackson	4,080	941.25	99.50	5,021.25	1.30
Jefferson	72	756.97	309.37	2,329.34	.63
Perry	13,084	12,739.39	1,385.56	27,208.95	9.82
Pope	32	10.0	3.8	45.80	.01
Saline	5,584	4,900.21	389.8	10,874.01	4.42
Williamson	7,792	6,564.03	323.45	14,356.03	5.00
208 Area	30,852	27,566.56	2,634.08	61,820.69	

Source: Illinois State Department of Mines and Minerals, 1976 Annual Coal Oil and Gas Report.

* This is a 12-month period (6/30/75 - 7/1/76).

Table 20
ACREAGES TO BE AFFECTED BY SURFACE MINING,
1980, 1985, AND 1995 FOR AFFECTED 208 COUNTIES

Time	County	Wooded	Agricultural Cropland	Agricultural, Pasture, Other	Mining	Urban	Public	Water	Total
1976-80	Jackson	420	1370	350	890	-0-	-0-	-0-	3030
	Jefferson	60	430	100	40	-0-	-0-	-0-	630
	Hamilton	*	*	*	*	*	*	*	*
	Perry	1826	5406	2546	970	-0-	-0-	-0-	10748
	Saline	665	1415	780	465	-0-	-0-	-0-	3325
	Gallatin	-0-	720	-0-	70	-0-	-0-	-0-	790
	Williamson	170	560	440	460	100	-0-	20	1750
	Total	3141	9901	4216	2895	100	-0-	20	20273
1981-85	Jackson	1661	1895	897	1210	70	-0-	-0-	5733
	Jefferson	297	1338	107	298	-0-	-0-	-0-	2040
	Hamilton	*	*	*	*	*	*	*	*
	Perry	1736	9469	2377	140	-0-	-0-	-0-	13722
	Saline	240	5735	640	-0-	80	-0-	20	6715
	Gallatin	420	970	-0-	-0-	-0-	-0-	-0-	1390
	Williamson	1630	2340	1470	430	320	220	10	6420
	Total	5984	21747	5491	2078	470	220	30	36020
1985-95	Jackson	2215	7477	2094	2349	20	-0-	150	14305
	Jefferson	-0-	-0-	-0-	-0-	-0-	-0-	-0-	-0-
	Hamilton	*	*	*	*	*	*	*	*
	Perry	2480	12497	1225	-0-	100	-0-	30	16482
	Saline	660	5177	1580	290	160	-0-	-0-	7867
	Gallatin	420	2161	740	170	-0-	-0-	-0-	3491
	Williamson	3560	2790	1590	2030	40	-0-	10	10020
	Total	9335	30102	7229	4839	320	-0-	190	52165

Table 20 (cont'd)

Time	County	Wooded	Agricultural Cropland	Agricultural, Pasture, Other	Mining	Urban	Public	Water	Total
1976-95	Jackson	4296	10742	3341	4449	90	-0-	150	23068
	Jefferson	357	1768	207	338	-0-	-0-	-0-	2670
	Hamilton	*	*	*	*	*	*	*	*
	Perry	6042	27372	6148	1110	100	-0-	30	40802
	Saline	1565	12327	3000	755	240	-0-	20	17907
	Gallatin	840	3851	740	240	-0-	-0-	-0-	5671
	Williamson	5360	5690	3500	2920	460	220	40	18190
	Total	18460	61750	16936	9812	890	220	240	108308

*Hamilton County data was not available. The projected surface mineable acreage is less than 2000 acres in Dahlgren Township.

Source: GERP&DC Staff.

future. Where mining could logically be expected, without blasting damage to developed areas, these have been mapped as mineable. Precedent exists for such classification: an active surface mine is in operation within the city limits of the Williamson County community of Hurst, and another is now stripping what was previously the Carterville (Williamson County) water supply reservoir. Very small communities have frequently been purchased for mining (where their underlying reserves have not already been mined). For example: Jamestown and Denmark in Perry County. Where regulations and land acquisition costs permit, such trends are likely to continue.

Most large coal companies do not rapidly resell land they have surface mined. Available information shows most 208 area surface mined land is retained by the producers or their subsidiaries (See Table 21). While in pre-reclamation law periods, the useability of such land was limited, much greater choices exist under current required reclamation techniques. In the past, large contiguous blocks of land which were row-crop farmland, pasturage, and woodlots before mining were reclaimed as forest, lake, pastureland and orchard. The resultant pattern of uses showed larger contiguous area in each use than the pre-mining pattern, even when total acreages did not change. Since stricter reclamation laws require mining companies to put much greater investment in assembled holdings, the apparent trend is to seek a post-mining use which will help defray reclamation costs. Amax Coal Co. maintains an agribusiness subsidiary, Meadowlark Farms, to farm reclaimed mine land, while Freeman-United Coal Co. pioneered by reclaiming some of its "new lands" to orchard before law required such use.

While such practices may vary with company philosphy, one good reason for retention of stripped land varies not with the owner, but with the coal reserves underlying it. Many areas contain more than one potentially strippable seam. Often, past mining pursued these seams only to depths of 50 or 60 feet, where they may now be strippable to 100-150 feet. Thus, some potentially surface mineable land has already been surface mined once, frequently in pre-reclamation law years. The major obstacle to mining these lands is that current reclamation laws set standards which would be impossible to meet, since top soil is not available on these lands. In many cases lowered reclamation standards for remining these lands could result in a substantial improvement in their appearance, useability and value. It is deemed likely that a workable compromise in reclamation standards for such lands will be developed in the next few years.

Table 21
OWNERSHIP OF 208 AREA SURFACE MINE-AFFECTED LANDS
IN 1971 FOR SOUTHERN ILLINOIS 208 AREA COUNTIES

Type	Pre-Reclamation Law	Post-Reclamation Law 1962-1971	Total % 1962-1971	Total Acreage 1961-1971
Private Individuals	33.93%	30.96%	32.86%	17,388
Coal Companies	46.50%	57.34%	50.41%	26,673
Misc. Companies*	11.47%	11.20%	11.37%	6,018
Recreational	.07%	0.00%	.04%	23
Federal & State	8.01%	.09%	5.16%	2,728
Municipal	.02%	.41%	.16%	85
All	100.00%	100.00%	100.00%	52,915
Acreage	33,836	19,079	52,915	

* "Miscellaneous companies" include but are not limited to coal company subsidiaries.

Source: Haynes, Ronnie J. and W. D. Klimstra, Illinois Lands Surface Mined for Coal (Carbondale, Illinois: Southern Illinois University, Cooperative Wildlife Laboratory, June 1975).

In summary, it is expected that the rate of land use for coal surface mining will increase substantially; but this increase will be gradual, with the greatest increase occurring after 1985 when demand for coal for coal conversion makes mining of currently marginal deposits more profitable. The land affected by mining will pass from various types of ownership into large mine-owned agribusiness holdings, if current trends continue. Much land inadequately reclaimed by present standards may be remined and re-reclaimed to improved quality.

Water Service Impacts Due to Labor Force Change

A further area of concern is the potential for rapid expansion of population in small communities due to energy industry expansion. Employment levels for the projected development were calculated on the following bases:

1) construction labor force per million tons of new underground capacity = 100;

2) construction labor force per million tons of new surface capacity = 50;

3) construction labor force per one million tons per year (400 mw) power plant = 840;

4) construction labor force per .6 million ton per year coal gasification plant = 1,900;

5) construction labor force per 10 million ton per year coal gasification plant = 3,600;

6) operating labor force per million tons of new underground capacity = 195;

7) operating labor force per million tons of new surface capacity = 118;

8) operating labor force per million tons per year (400 mw) power plant capacity = 100;

9) operating labor force for a .6 million ton per year coal gasification plant = 415; and

10) operating labor force for a 10 million ton per year coal gasification plant = 1,075.[1,2,3]

It is assumed that construction periods are three years for surface mines, and five years for deep mines, power plants, and gasification plants. Construction labor forces are assumed to peak in the middle year at the above figures, rising and descending to zero. Operating labor forces are assumed at half strength in the last year of construction, and at full strength the following year.[4]

Using these levels to simulate actual employment impacts of construction and operation of the mines and related facilities, annual totals for

construction and operation labor force force totals were forecast. In addition to the surface and underground mines mentioned above, the following were projected.

1.) 160 MW coal fired power plant on line in 1978 (Lake of Egypt), Williamson County;

2.) 150 MW coal fired power plant on line in 1983 (Lake of Egypt), Williamson County;

3.) 400 MW coal fired power plant on line in 1985 (Cambria), Williamson County;

4.) 200 MW coal fired power plant on line in 1990 (Equality), Gallatin County;

5.) 600 MW coal fired power plant on line in 1995 (Pinckneyville), Perry County;

6.) Demonstration coal conversion plant in 1986 (Willisville), Perry County;

7.) Commercial coal conversion plant in 1991 (Willisville), Perry County;

In all, these projects would require 14 1/3 million tons of coal per year and about 48 million gallons of water per day.

As mentioned above, there are other possible sites in the area for such facilities. Those chosen here are based on the best information available, from all sources. The attrition and requirement of the existing operating labor force for the energy sector was assumed to be 6 2/3% year, such that 75% of all current job holders would be eliminated by 1995. This high retirement of present jobs helps simulate anticipated labor productivity increases in mining.

The total projected labor force for the energy sector is shown by counties in Table 22, while operating and construction jobs are shown graphicly in Figure 18 and 19.

It is clear that the greatest projected increase in employment is projected for Perry County and is due to the construction of the two proposed

Figure 18
208 AREA ENERGY RELATED
EMPLOYMENT (OPERATING JOBS)

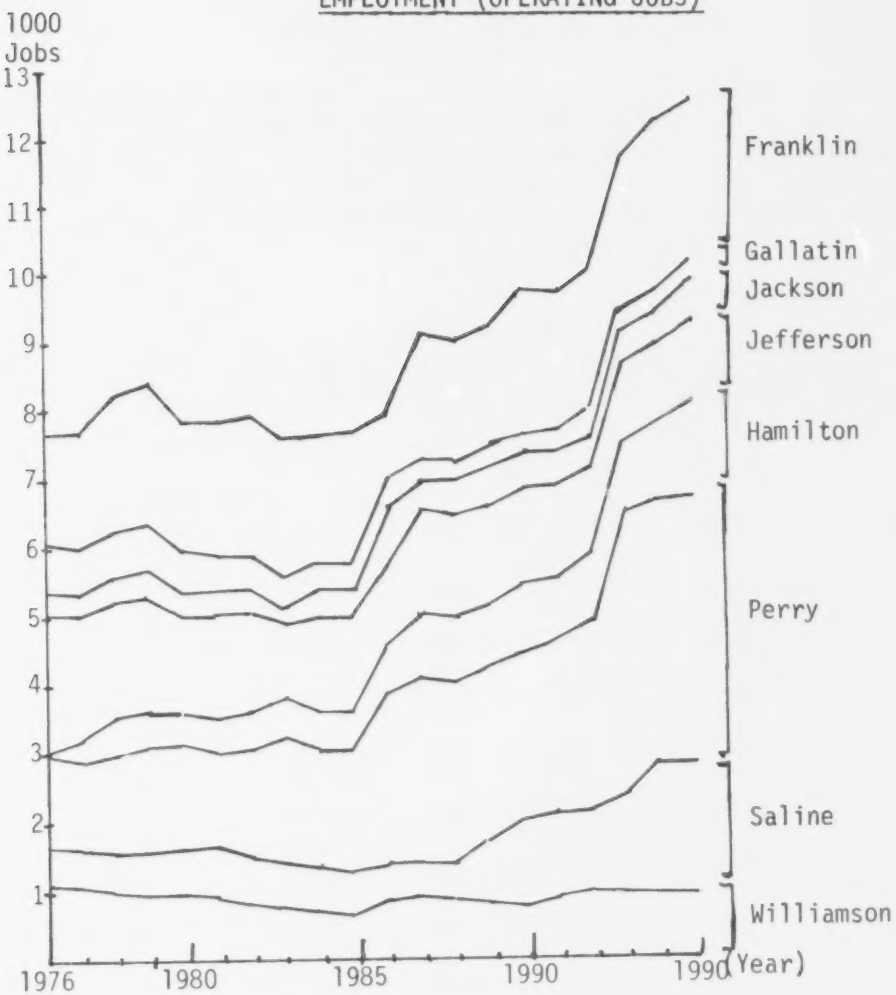
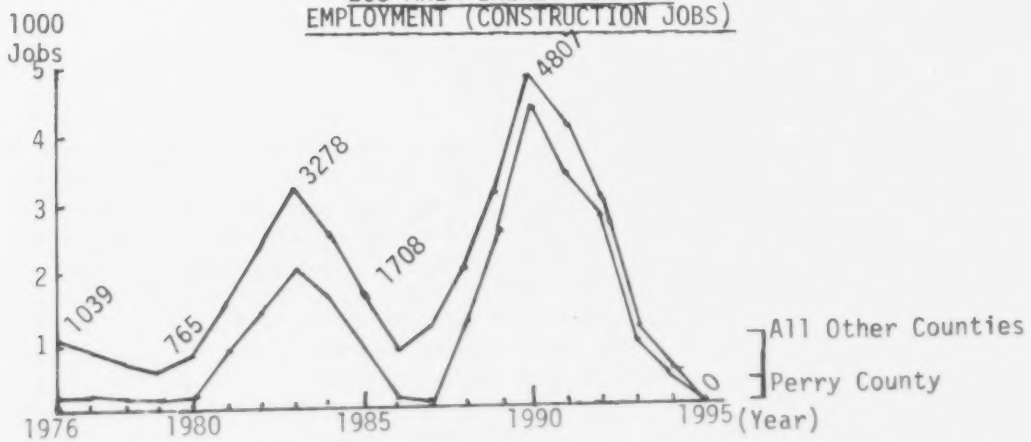


Figure 19
208 AREA ENERGY RELATED
EMPLOYMENT (CONSTRUCTION JOBS)



Source: GERP&DC Staff.

gasification plants. Franklin County shows sustained high energy employment, but little growth. Most of the projected new capacity in Jefferson and Franklin Counties is balanced by the closing of older mines. Should coal conversion expand more rapidly than projected, employment growth impacts on affected communities could be severe.

Table 22
208 AREA ENERGY RELATED EMPLOYMENT CHANGE ESTIMATED FOR 1980, 1985, 1995, (INCLUDING CONSTRUCTION JOBS)

	Jobs				
County	1975	1980	1985	1995	1995 as % of 1975
Franklin	1913	2152	1987	2383	125%
Gallatin	763	578	409	254	33%
Hamilton	170	528	682	1362	801%
Jackson	315	417	357	638	113%
Jefferson	2054	1556	1493	1135	55%
Perry	1500	1707	2576	4233	282%
Saline	654	784	769	1607	246%
Williamson	1047	843	647	842	77%
ALL	8690	8930	9400	12454	143%

Source: GERP&DC staff.

Readers will note that the timing of the various mines, power plants, and conversion sites in the analysis is, to a large degree, arbitrary. Limitations on this arbitrariness were imposed only by the announced dates for known projects. The order of entry of projected mines after 1982 was based on a largely intuitive analysis by the GERP&DC staff which incorporated knowledge of mining costs and reserve ownership. Recently, large blocks of reserves have been purchased in the 208 area. It is felt that most of these will not be developed for at least 15 years. A fortuitous aspect of the analysis used is that by juggling the dates of entry for various surface and deep mines the final results are not greatly affected. The significant impacts due to labor force expansion are those imposed by the construction labor forces for coal conversion plants.

In this light, it is useful to discuss the suggested Gallatin County conversion plant and an alternative site in eastern Williamson County. The Gallatin County site reflects the ready availability of coal, water, and the assumed high demand for synthetic fuels. A conversion plant was at one time considered for a location near the town of Crab Orchard by Peabody Coal and Panhandle Eastern Pipeline Co.[5] No formal announcement has been made of this plan and, at present, the proposal appears moribund. Water for this site would have come from proposed reservoirs to the north and south of Crab Orchard. Some readers may wish to consider the transfer of the conversion plant from Gallatin County to the Williamson County site. In conclusion, changes which do not alter the projected regional coal production by more than 5% will do little to alter the nature Figures 18 and 19 and Table 22.

Given that the proposed coal conversion facilities are most likely to stimulate rapid urban expansion with the associated demands upon housing, schools, water and sewer facilities, it is of interest to estimate what level of increased population growth the projected energy-industry growth might produce. One recent study found that energy related population increases were larger than the energy labor force by factors of about 3.75 during construction, and 6.12 during operation.[6] These levels are not appropriate for Perry County, as they are primarily based on recent events in Sweetwater County, Wyoming, where very little service infrastructure and a strictly limited labor pool was available.[7]

Evidence exists that relatively large construction projects may be undertaken in the 208 area without serious affects on nearby communities. A 1260 mw minehead power plant was completed at the small Randolph County community of Baldwin (population 467) in 1976. This power plant was completed ahead of schedule by a labor force which peaked near 1300, yet little new residential or commercial construction occurred, and community "growing pains" appear to have been few. Workmen from a broad area commuted to the construction site for several years. One key to this process is the relative proximity of the Randolph-Perry County area to the Saint Louis-East St. Louis area. Thus, while 1970 census data shows that 80 to 95% of those working in 208 area counties live in the community in which they are employed, it is doubtful that this is true for Southern Illinois construction workers.[8] The construction of such a large facility as the proposed Perry County plant is likely to bring some new residents, for the Southern Illinois labor force has had little experience in refinery construction, and the communities close to the proposed construction site are small.[9] GERP&DC staff have assumed that about 75% of the construction labor force will not reside locally, while 80% of the operating labor force will live in the area, and that 75% of the secondary support labor during construction and operations will be previous area residents. If it is further assumed that 60% of

the construction labor force will be married with an average family size of 3.7 persons, and 40% of the support crew will have a similar family size, the number of expected new residents is, therefore, about 1,914.[10] Using similar calculations based upon the same assumptions, the operating labor force would generate about 693 new residents. Since the proposed facility is close to Randolph County, we have assumed that 50% of the new residents will live in northwestern Perry County. Thus the total number of new county residents for the demonstration plant would be about 960 during construction and about 350 once operations began. The commercial plant proposed for construction by the early 1990's is much larger, and population increases of 1,815 during construction, and 1,796 at the start of its operating life are predicted for Perry County.

Population impacts of these magnitudes may represent underestimates since both demonstration and commercial facilities would be built during times when the regional coal industry was also experiencing rapid growth, so that existing vacancy rates in housing should not be expected. No other portion of the 208 area seems likely to undergo large population growth in a short period of time due to energy related development. However, it should be borne in mind that such estimates are very tentative, and that the region is likely to experience the development of an additional commercial gasification plant in the less developed Gallatin County area shortly after the end of the forecast period. Further, energy related growth has been projected to grow smoothly over the forecast period, however, past area production figures show that past growth has been cyclical. The coal industry, at least, does not appear to respond quickly to upward changes in demand, but rather to respond, perhaps belatedly, in leaps and bounds.

Since a large portion of the area's coal demand is derived from utility demand, it seems apparent that power plant construction may occur in concentrated surges also. It is clear that the period 1978-1983 will be a period of rapid coal industry expansion, and the forecasts of synthetic fuel demand show extremely rapid growth in the last decade of this century. It is therefore possible that the 1978-1983 period of high growth will be followed by a "dormant" decade of slow expansion, to be followed by an even greater expansion in the 1990-2000 decade. It might be prudent for community planners in the 208 area to regard the 1978-1985 period as a dress-rehearsal for the second high growth period, when the likelihood of truly rapid regional growth appears greater.

Revenues Sources for Energy Growth-Impacted Communities

A major source of difficulties for communities experiencing rapid expansion of energy related facilities is the time gap between the initiation of construction and the inception of the facility's operation, when its revenues become taxable. Between these dates, affected communities and counties may experience rapidly escalating needs for police, fire, water, and sewage services, as well as major strain upon the whole structure of local government, designed and financed for pre-energy boom levels of operation. In the preceeding section, we have seen that the largest expansion of local population may occur during the construction of coal coversion plants. Within the forecast period 1975-1995 in the Southern Illinois 208 area, it is clear that a major expansion of the coal industry is beginning in Perry County, and that similar expansion may occur after 1990 in Gallatin County. While the financing of the capital costs of environmental protection of water quality is borne mainly by the State and Federal level of governments and by the industrial firms involved, it is nonetheless true that local governments will have to finance all or a substantial part of the costs of expanded water supply and the operational and maintenance costs of industrial and domestic fluid waste treatment. It is appropriate, therefore, for this report to review feasibility and equity considerations for some potential strategies for raising revenues to meet these water quality related needs.

208 area counties do not appear to have adequate, uniform methods of providing revenues to extend public services during the construction period of major projects. Reviews of area property assessment practices show only arbitrary attempts to assess mineral rights at the market value of the coal deposits involved. Coal valuation is complicated by incomplete mapping of reserves, mapping of reserves at scales inappropriate for assessment of individual small holdings, variations in purchase offer and royalty contracts made by holding firms and producers, and differing practices by buyers in purchasing control of surface-mineable vs. underground mineable reserves. It is not likely that these problems will be solved in the foreseeable future. Real property taxation contains inherent inequities as a method of recovering the value of extracted minerals; for example, annual taxation at flat rates most heavily burdens minerals mined last, i.e., those of least economic value. Additionally, it does not appear to be common practice to make adjustments on land valuation before or after mining to compensate the county for losses in revenue due to reclamation failures or potential county property damage due to possible mine subsidence.[11] What has been said of property taxes applies equally to transfer taxes on land or mineral rights. Given these problems, much attention has been given to the possibility of a severance tax which rebates revenues to counties in proportion to production. While such a tax has much to recommend it from the county's point of view, it would do little for counties whose

production is small, but which may be experiencing the simultaneous construction of new mines, a power plant, and/or a coal conversion facility. There will always be a natural resistance to such taxation from those whose primary concern is the profitability of the industry (plans for pre-payment of industry taxes are not deemed likely to succeed, either). In defense of severance tax opponents, it can be said that such a tax of $.30 a ton (or $.0125 to $.0136 per million Btu on 208 area steam coal) amounts to a reduction in the competitive sales radius of 208 area coal of about 40 miles (at $.0076 per ton mile), or the equivalent cost of a new 2.0 million ton per year underground mine with about 400 jobs for every 6 years of taxation (assuming production at 30 million tons per year). It will doubtless be easier to gain support for a severance tax at a time when production is obviously expanding, i.e., 1979-1985. It is likely that proponents of a severance tax will find it prudent to make special provision for coal produced by less profitable smaller mines.

A source of some county compensation for real property devaluation for lands affected by coal mining prior to August 3, 1977, has recently been provided by the Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87) which provides that some revenue (35¢ per ton on surface mined coal, 15¢ per ton on underground mined coal) from a severance tax on coal mines be made available for reclamation of coal mine affected lands of all types, including the filling of abandoned underground mines to reduce subsidence.[12]

None of the above measures meets the full need. Further, all are primarily directed at increasing county revenues, while the greatest need is likely to be felt by communities and school districts in highly localized areas.[13] At this writing, it appears that the most promising sources of revenue for energy impacted communities are federal and state funds. One such source would be the establishment of a Federal Energy Development Impact Assistance Fund, providing loans and grants to localities on a per capita basis.[14,15] Such a program could be enhanced by increased FHA and FmHA mortgage ceilings, and/or by direct federal grants.[16] Another alternative is to provide an Illinois State Energy Development Assistance Fund similar to the proposed federal fund with revenues to be earmarked for communities affected by projects which the state has subsidized, as it did the New Athens Coalcon Gasification Project.

In conclusion, most existing and popular remedies appear to be inadequate. The timely identification of localities likely to be placed in financial stress, and the determination of their fiscal needs will depend on continuing review of local developments by community and

regional planning officials. It is important, considering present uncertainties and proprietary restrictions on industry planning information, that such review be the responsibility of those with some technical, geological, and fiscal insight into energy development potentialities.

Water Quality Impacts Due to Energy Industry Waste Disposal

This section is not intended as a definitive analysis of expected waste disposal impacts from existing and future mining, electricity generation, and gasification - liquifaction facilities. However, it is possible to provide a "shopping list" of potential water quality impacts due to such facilities.

Large (over 600 mw) coal fired thermal electric plants constitute three important potential sources of water pollution. If straight-through cooling is employed, discharged cooling water can provide a point source of thermal pollution. Available control technologies include wet cooling towers and cooling ponds with aeration equipment. Future coal fired plants in the 208 area are likely to be equipped with non-regenerative stack gas-scrubbers which produce sulfate sludges in large quantities (perhaps 10.5 million cubic yards in the 20 year lifetime of a 800 mw plant).[17] These must be stored, and kept out of precipitation runoff to streams. A "complimentary" type of pollution may develop in acid runoff from stockpiled coal. Runoff from both sources may be readily impounded and, if necessary, treated prior to release.

Coal gasification plants will produce all the above opportunities for pollution, plus several others. While the gasification process consumes large quantities of water, most of it is used for evaporative cooling (utilization of wet cooling towers is almost a certainty in humid regions), and the rest is consumed as part of the product. What is released is a moist, basic ash from the converter.[18,19,20,21,22,23] This material can be buried, in active or abandoned surface mines, or backstowed in underground mines (mine safety regulations permitting). If dried, such ash may be applied as a surface material to allow revegetation of acid spoil. Acreage where this method could be used exist at the Perry, Gallatin, and Williamson County conversion plant sites. It should not be anticipated that application of this ash would greatly reduce acid runoff from spoil, since it would reduce, not eliminate, the contiguity of oxygen, water, and iron pyrites in the spoil. As long as such spoil is above the water table, acid leaching may occur. It is also possible that such ash buried or backstowed below ground could contaminate groundwater. This disposal alternative requires a geological analysis on a site by site basis.

Liquifaction plant wastes (the proposed Illinois Coal Gasification Group plant in Perry County would produce both liquid and gas products) will include fluid wastes requiring pre-release treatment. A plant producing liquid hydrocarbons may be expected to attract petro-chemical process industries. While such industries would present their own spectrum of waste disposal problems, they may be customers for the elemental sulfur and sulfuric acid from the stack gases of the conversion plant, allowing economically feasible substitution of regenerative stack gas scrubbers for the non-regenerative and subsequent elimination of sludge disposal problems.

Expanded coal mining will mean expanded production of wastes from coal preparation. Modern preparation techniques do not produce gob and slurry with enough salvageable coal fines to permit recycling. Disposal of such wastes is an integral part of modern area surface mining. If underground mines are not permitted to backstow gob in depleted sections of the mine, it is possible to hydraulicly or pneumatically flush such wastes into abandoned mines through boreholes. This technique is expensive, and requires large mine voids close to the gob production site. In some parts of the 208 area, the cost of such gob disposal could be partly justified by flushing gob into mine voids beneath urban areas, where the technique has shown promise in preventing mine subsidence.[24,25]

Since problems of gob and slurry disposal form a major focus of other elements of the Southern Illinois 208 Project, no further discussion is undertaken here. Instead, it is desirable to consider a particular threat to 208 area water quality which can be expected to develop from one future production sector of the industry.

Older Seams and Smaller Mines

The southernmost portions of Gallatin, Saline, and Williamson Counties, where the surface geology includes subcrops of coal seams stratigraphically below the Davis and Dekoven coalbeds, as well as Pope and Hardin Counties in their entirety, comprise a special problem from the standpoint of this report. While it is doubtful if the coal resources of this area are sufficient to support exploitation on a scale similar to that discussed in the preceding sections of this report, i.e., mines with annual production capacity over 500,000 short tons, it is not impossible. No definitive statement can be made about the potential of these reserves, as they have not been mapped, nor have their reserve tonnages been tabulated and assessed in published material, except for the tentative subcrop lines mapped for the Willis, Reynoldsburg, and New

Burnside seams by Smith.[26] It is likely that economically mineable reserves for the 1975-95 period are limited to highly localized lenses of less than ¼ million recoverable tons each. Some of this coal is locally known to be low in sulfur.

The importance of these minor coal-beds lies in their position astride lands valued for recreational, aesthetic, and related purposes which may be in potential conflict with coal extraction. These lands are split between the watersheds of the Saline and Ohio Rivers, and the small streams dissecting the forested uplands of this region constitute some of the higher quality streams in the 208 area.[27] Much of the potentially affected land lies within the Shawnee National Forest, where expanded mining would depend on an environmental impact statement not likely to be forthcoming before 1985.[28] GERP&DC staff have been informed that the Illinois State Geological Survey is currently mapping areas in the Davis and Dekoven seams at the northern edge of this area. It would be desireable for such work to be funded on a scale sufficient to allow geologic mapping not only of these seams, but all the lower seams, expecially if attention were given to the assessment of the acid production potential of rock strata overlying these seams within surface mineable depths. The utility of such information would be enhanced if it were available within the next few years, <u>before extensive mining of these seams begins</u>.

The exploitation of coal seams in this region in past years has been limited to small scale surface mining by operations of one to five years extent. These are "spot" mines, whose economic viability varies with mining costs, short term price fluctuations, and the degree of rigor with which reclamation and water quality standards are enforced. Current surface mining regulations under P.L. 95-87 are expected to have a depressive effect upon such operations, after January 1979.[29] While coal mining in these seams has not exceeded 50,000 tons or 10 acres per year since 1956, in the absence of information to the contrary, one must conclude that the potential for substantial stream quality degradation is significant.[30]

FOOTNOTES FOR CHAPTER 4

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